Box Hill - South Tributary Restoration Monitoring Report

Prepared for:
The Harford County Department of Public Works

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KCI TECHNOLOGIES

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1.0 INTRODUCTION

Harford County has recently completed the construction of a stream restoration project within the Box Hill – South Tributary to Bynum Run, which is situated along the southern boundary of the Box Hill North subdivision. Specifically, the project is located south of Kensington Parkway between Harrogate Way and Laurel Bush Road, in Harford County, Maryland (see Figure 1 – Site Vicinity Map).

The 1100-foot channel receives uncontrolled stormwater runoff from a closed storm drain system. The predominate landuse is medium to high-density residential and commercial development. Prior to restoration, the stream channel was experiencing excessive bed and bank erosion and had become incised, exposing bedrock in some locations. Lateral channel migration into adjacent backyards was also occurring, creating a hazardous situation and threatening adjoining property.

This report presents the methods used to monitor the success of the stream restoration project, as well as the results, a discussion, and the conclusions from the Year One post-construction monitoring effort. The report will serve as the baseline conditions report to which subsequent yearly monitoring events will be compared. Reports for the yearly monitoring events that will follow the Year One monitoring will not repeat the introduction and methodologies sections, but instead will consist of supplements that include only the results, discussion and conclusions sections for those years, which can then be added to this monitoring report.

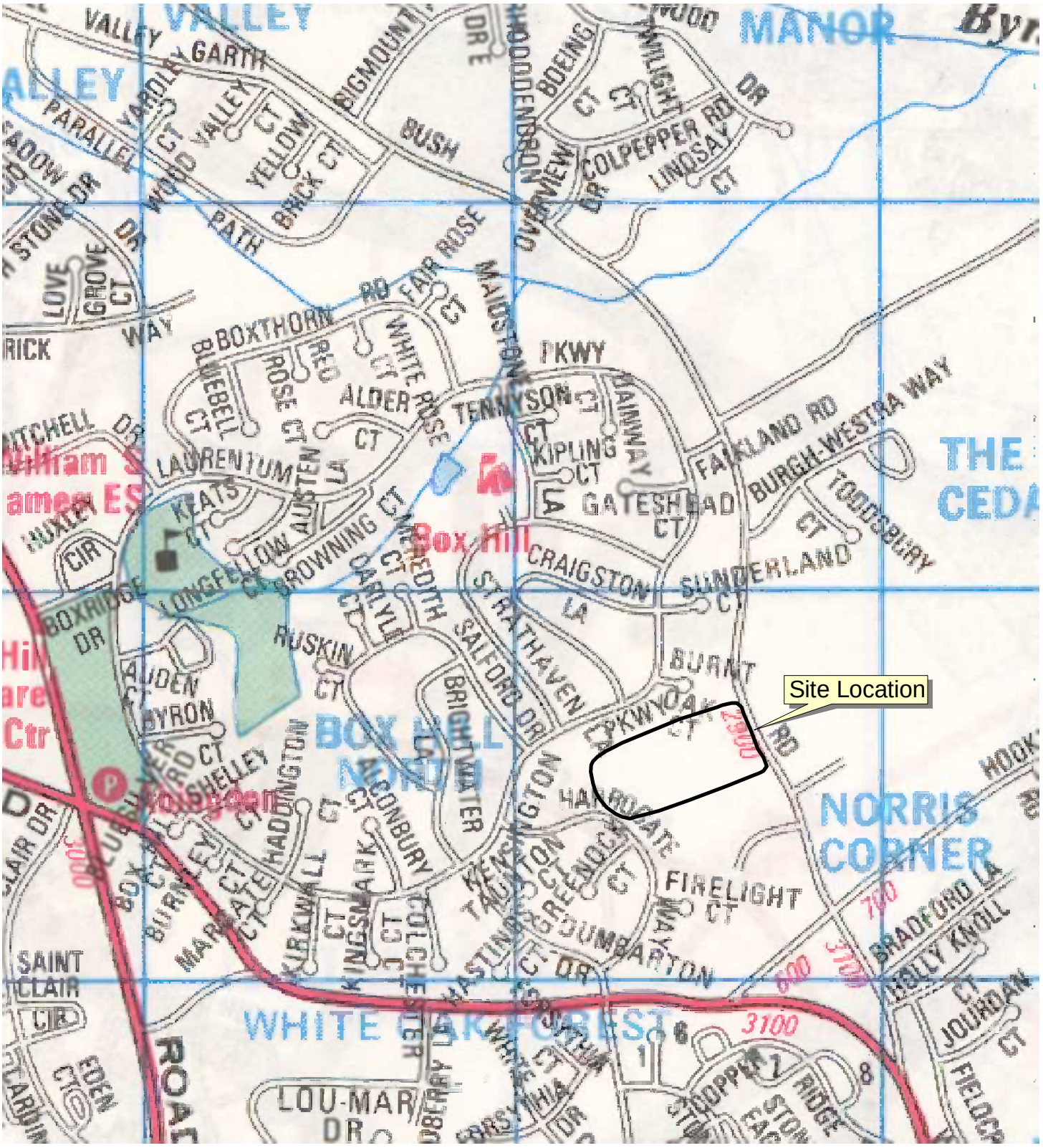
1.1 DESCRIPTION OF MITIGATION EFFORTS

The United States Army Corps of Engineers (COE), under the Maryland State Programmatic General Permit (MDSPGP), Category III, authorized the 1,100 linear foot Box Hill – South Tributary restoration project, which was completed in the Fall of 2003. The Maryland Department of the Environment (MDE) issued a letter of authorization (00-NT-0542/2000161040) defining special conditions for the mitigation work required by the ACOE permit, which are outlined later in this report. The main purpose of the project was to reduce lateral channel movement and provide grade control in order to protect personal property and improve the hazardous conditions. To improve the conditions, various instream structures, including step pools, boulder spurs, vane weirs, boulder bank stabilization, and coir fiber rolls were utilized. In addition, the entire site was planted with native trees, shrubs and live stakes. Refer to Appendix A for photographs depicting the overall site conditions and restoration applications.

1.2 OVERVIEW OF MONITORING ACTIVITIES

Monitoring protocols for the Box Hill South Tributary site were developed in order to evaluate the success and stability of the restored stream channel and involve fluvial geomorphologic assessments, macroinvertebrate sampling, inspections of channel stabilization techniques, and vegetative stabilization inspections. The monitoring program, as detailed briefly below and in greater detail in the methodologies section, is conducted on an annual basis during a five-year period, beginning in 2004, as required by MDE permit conditions.

Fluvial geomorphologic monitoring is conducted in order to evaluate the bed and bank stability and the establishment of riffle/pool sequences. Six monumented channel cross-sections were established during baseline monitoring at various critical locations along the restored tributary. Each section is measured annually during baseflow conditions to evaluate channel stability. Topographic survey of the entire restored stream reach was completed during baseline monitoring for comparison to as-built and/or final design plans in order to assess changes to the channel and floodplain. Subsequent annual monitoring events do not include completion of a full topographic survey of the channel.



Box Hill- South Tributary Restoration
Site Vicinity Map

ADC Map 24
C - 6

N

Not to Scale

Harford County, Maryland
ADC Map
ADC of Alexandria, 1999

Pebble counts are conducted at two riffles and one deposition bar annually. Bed and bank pins installed during baseline monitoring conditions are also monitored annually to assess general bank stability.

Cursory inspections are conducted annually for each of the installed channel stabilization techniques, including both in-stream structures and non-vegetative bank stabilization techniques. Vegetation inspections are also conducted annually and include a cursory assessment of the success of the installed bioengineering materials (live stakes) and other riparian vegetation, as well as an assessment of volunteer species that are becoming established.

To date, macroinvertebrate sampling has involved both pre and post construction assessments and is continuing throughout the five-year monitoring period to track changes in macroinvertebrate populations associated with channel improvements.

Because the results section of this report covers the Year One baseline conditions monitoring effort, a brief explanation is provided comparing the intended design features to the post-construction monitoring results.

1.3 GOALS AND OBJECTIVES

As detailed above, the Box Hill – South Tributary project was authorized by the COE under the MDSPGP, and includes specific conditions outlined in the MDE permit Number 00-NT-0542/2000161040. One of the conditions includes monitoring the project for a period of five years. During this time period, the County is expected to identify and evaluate changes in channel cross section; pattern and profile; bed materials; channel stability; vegetation viability; and structure stability and condition.

As a goal of this project, Harford County expects improved pool/riffle formation, reduced embeddedness and sedimentation, and overall improved aquatic and riparian habitat quality. In addition, Harford County anticipates less hazardous conditions and the protection of personal property that abuts the stream.

2.0 METHODOLOGIES

2.1 GEOMORPHIC ASSESSMENT

The fluvial geomorphic assessment is conducted to quantify basic stream characteristics including bed and bank stability as well as riffle/pool sequences. Full topographic survey of the restored stream reach, and cross-sectional and longitudinal profile surveys are completed to establish baseline conditions, compare the Year One post-construction monitoring results to the proposed design plans provided by the County's original design consultant, Greenhorne & O'Mara, Inc. (G&O) and ultimately to compare any changes in channel geometry and slope that occurs over subsequent annual monitoring events. Pebble counts are performed to characterize channel substrate and to estimate channel roughness. Bank and bed pins are monitored to determine rates of potential bank and channel bed erosion or aggradation. Detailed methods are described below.

2.1.1 Topographic, Longitudinal Profile and Cross-sectional Surveys

Full topographic survey of the project site was completed during the Year One monitoring effort to develop mapping of the baseline post-construction conditions. Features located during this survey include elevation shots to develop contours at one-foot intervals, elevations along the field identified

location of the centerline of flow or thalweg of the stream, the locations of installed in-stream structures, and pool/bar formations. A longitudinal profile of the stream was developed for the baseline conditions based on the thalweg survey.

This topographic survey serves as the baseline field conditions for comparison during annual post-construction monitoring efforts. The plotted longitudinal profile also serves as the baseline for comparison during subsequent years and is used to track changes that occur in the bed structure sequences. Because digital files of the original design plans or as-built plans completed by G&O were unavailable to KCI, no direct comparisons could be made between those surveys and the baseline condition surveys. Instead, visual comparisons are made and generally described in the results of this Year One monitoring report. It should be noted that stationing along the channel thalweg, as surveyed by KCI, differs from stationing on the as-built plans. Stationing between the design and 2004 field surveyed profile differ due to variations in the thalweg placement and field conditions. In addition, the starting point of the original design survey was located at the culvert that passes under Laurel Bush Road. Whereas, the starting point associated with the 2004 survey was approximately fifty feet upstream of this location, just downstream of the limit of the channel work. Subsequent monitoring data will be compared to the 2004 stationing and profile.

In order to establish locations where fluvial geomorphic characteristics of the channel could be measured and compared from one year to the next to assess bed and bank stability, permanent cross-sections were established at six (6) locations along the channel; three within riffles, two within pools, and one within a glide area. Each cross-section was monumented on both sides of the channel. In discrete areas, the monument consists of a carriage bolt set into concrete in a PVC pipe cast. In other areas that are frequented by landowners, the monument consists of a single piece of rebar driven flush with the ground surface. The monument locations and elevations were surveyed and added to the topographic base mapping. Cross-sections are field surveyed annually at each of the following stations using a laser level, calibrated stadia rod, and measuring tape.

Section 1 - Station 1+70	Section 4 - Station 6+48
Section 2 - Station 3+90	Section 5 - Station 7+92
Section 3 - Station 4+98	Section 6 - Station 8+87

Surveyed cross-sections are plotted and each of the annual monitoring years are overlain and compared to the baseline condition cross-sectional measurements. The focus of these evaluations is on bankfull width, mean depth, width/depth ratios, and overall bank stability.

Because bankfull elevations were not evident in the field, especially in areas where imbricated walls were placed, elevations to generate hydraulic geometry values were selected based upon top of bank design features. These set elevations, determined at each cross section listed above, will be utilized during future monitoring events to generate hydraulic geometry values that are directly comparable between each monitoring event.

2.1.2 Wolman Pebble Counts

Channel substrate composition is an important aspect of a stream's geomorphic character. Sediment size provides insight into channel roughness and flow determination using incipient motion analysis such as the Shields Diagram. Generally, the most efficient method to determine sediment size for the channel bed and banks is the Wolman pebble count (Leopold et al., 1964).

The Pebble Count Procedure was adapted from *Stream Channel Reference Sites: An Illustrated Guide to Field Technique* (Harrelson et al, 1994). Three sites were chosen for the post-construction monitoring

analysis. Two sites are located in riffles and the final count situated in a bar formation. A minimum of 100 particles is obtained to ensure a valid count. Particles are then tallied by using Wentworth size classes in which the size doubles with each class (<2, 2, 4, 8, 16, 32, etc.). Sampling at the transects begins at a randomly selected point. The intermediate axis (neither the longest nor shortest of three mutually perpendicular sides) of each collected particle is measured. Embedded particles or those too large to be moved in place are measured at the smaller of the two exposed axes. The sampler moves upstream or downstream randomly to take a sample total of at least 100 particles. After counts and tallies are completed, the data is plotted by size class and frequency on log-normal paper.

2.1.3 General Bank Stability (Bank Pins and Bed Pins)

To monitor channel adjustments, KCI installed bank and bed (toe) pins at four of the six permanent cross-section locations and in two other areas considered to have a higher potential for erosion based on field conditions at the time of monitoring. Pins were not installed within the remaining two cross sections because these areas did not show any signs of erosion or instability. Three-foot pins consisting of rebar were hammered into the top and toe of the bank until approximately one-inch was exposed above the surface. Following installation, the offsets for each bank and bed pin were measured, beginning from the right monument (looking upstream/up-station along the survey baseline) at each of these cross-sections. Three sets were installed at riffle locations, two sets in pool regions, and one set was installed within a glide area. Locations and offsets for the pins are listed below. No offset locations are associated with pins that were located outside of surveyed cross-sections.

Station 4+98 - (Cross-Section 3)
Offset 0+07.2 Bank Pin (Right Bank)

Station 6+10
Mid-bank Pin (Left Bank)
Toe Pin (Left Bank)

Station 6+48 (Cross-Section 4)
Offset 0+04.8 (Right Bank)

Station 7+25
Mid-Bank Pin (Left Bank)
Toe Pin (Left Bank)

Station 7+92 (Cross-Section 5)
Offset 0+24 (Left Bank)

Station 8+57
Mid-Bank (Right Bank)
Toe Pin (Right Bank)

Station 8+87 (Cross-Section 6)
Offset 0+09.3 (Right Bank)

The exposed length of each pin was measured during Year One monitoring efforts and the pins are surveyed annually to assess bed and bank erosion. This information is useful in determining if installed stream features or other circumstances occurring within the restored stream or its watershed are resulting in any new channel degradation, bank erosion or channel accretion.

2.2 CHANNEL STABILIZATION TECHNIQUE INSPECTIONS

A cursory visual assessment is conducted for each of the installed channel stabilization techniques, including cross vane weirs, boulder banks, step pools, boulder spurs and coir fiber rolls. Evidence of movement within the structure, excessive scour, undercutting, erosion, or other type of failure of the technique is photographed and notes are recorded as to the degree and extent of the problem. No formal measurements of these structures/techniques are conducted following the baseline condition monitoring.

2.3 VEGETATIVE STABILIZATION TECHNIQUE INSPECTIONS

Informal visual inspections are conducted to generally assess the establishment and survivability of vegetative stabilization techniques along each 50-foot length of the stream channel. The first item evaluated is the overall percentage of areal vegetative cover (i.e., both installed materials and volunteer species) that has become established and is providing functionality along the banks. Functionality is defined as evidence of root growth that is maintaining the integrity of the stream bank. Areas where vegetative establishment within the project limits is sparse or non-existent are areas that may become prone to erosion. These areas are evidenced from a lowering of this percentage.

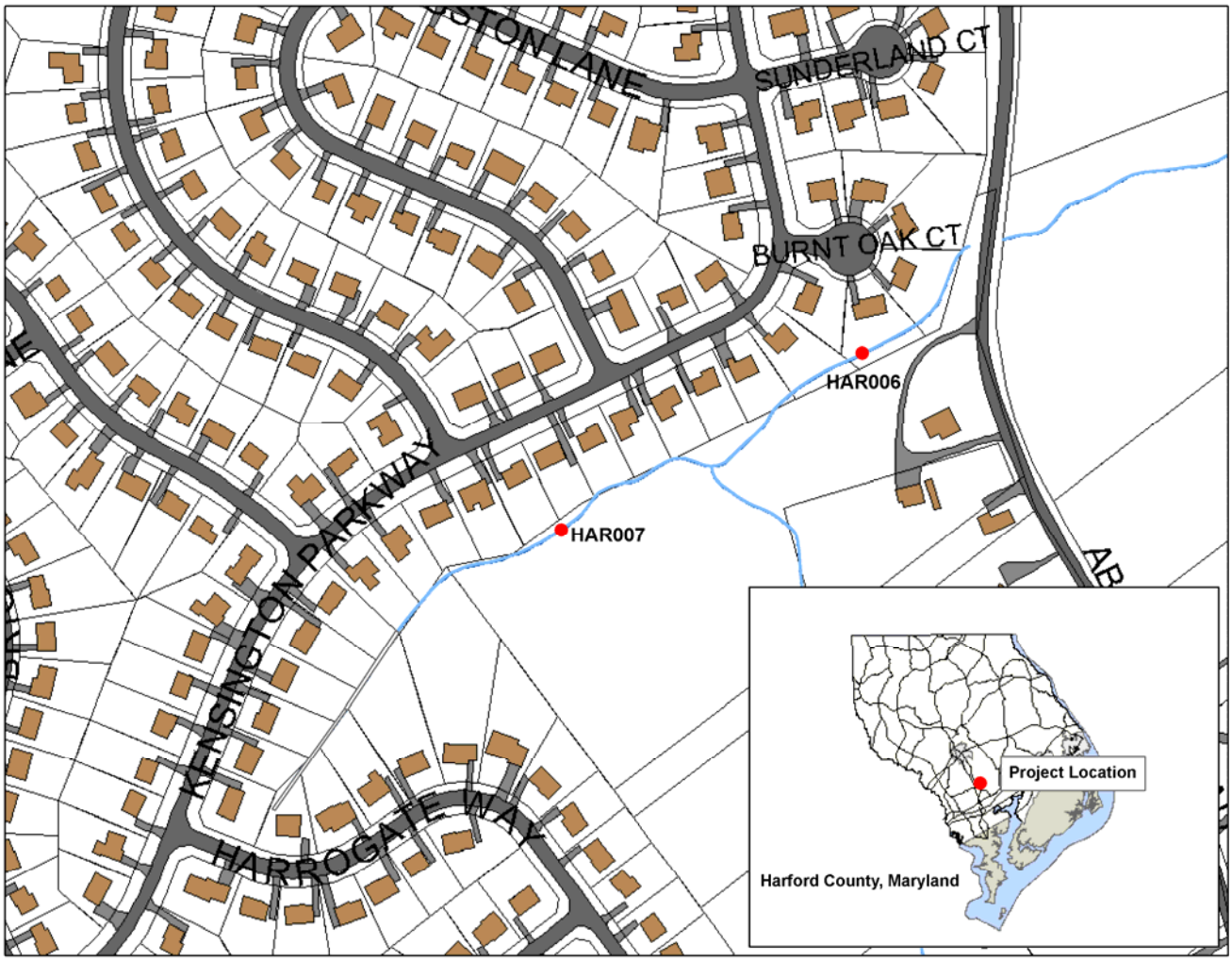
The second item assessed is the percentage of plant survivability of both the installed vegetative stabilization techniques (i.e., live stakes, riparian plantings, and permanent seed) and any volunteer species establishing within the above areal coverage. Survivability is defined as evidence of growth leading to the development of healthy leaves and roots. Because as-built plans illustrating the exact locations of the installed plant materials were not available and are not always easily discernible in the field, formal determinations regarding plant survivability of only the installed vegetation have not been performed.

During the above inspections, the general health or any other apparent issues concerning the vegetation is noted. Areas where vegetative stabilization of the banks is failing significantly or the vegetation is showing signs of stress, disease, pest/predation problems, or poor survivability are also noted and their approximate location is recorded. The presence, location and extent of any invasive species becoming established that could potentially displace native plantings are also recorded.

2.4 MACROINVERTEBRATE SAMPLING

To date, both pre and post construction macroinvertebrate sampling has been conducted within the study reach (refer to Figure 2 for sampling locations). Sampling will continue throughout the five-year monitoring period to track changes in macroinvertebrate populations associated with the channel improvements. Sampling was initiated in 1998 and followed the Maryland Save Our Streams (SOS) Project Heartbeat protocols. In the summer of 2003, the Maryland Department of Natural Resources (DNR) Monitoring and Nontidal Assessment Division began collecting and analyzing the macroinvertebrate samples following the Maryland Biological Stream Survey (MBSS) protocol. Data is being collected and analyzed based on this methodology.

FIGURE 2. BOX HILL – SOUTH TRIBUTARY MACROINVERTEBRATE MONITORING LOCATIONS



3.0 MONITORING YEAR 1: RESULTS AND DISCUSSION

3.1 FLUVIAL GEOMORPHIC ASSESSMENT

3.1.1 Topographic, Longitudinal Profile, and Cross-sectional Surveys

The topographic survey of the project study area was completed by KCI in September 2004. The mapping developed from this survey serves as baseline post-construction condition mapping to compare field conditions measured and inspected during future annual monitoring events. As mentioned above, the locations of each of the installed in-stream structures (cross vane weirs, boulder banks, step pools, and boulder spurs) were surveyed and included on the base mapping, as were the locations of significant pools and bar features. (Refer to Appendix B for baseline condition topographic mapping)

The topographic survey conducted by KCI is generally consistent with the proposed design drawings developed by G&O in 2002. The longitudinal profile data was analyzed to estimate the slope of the restored channel. The slope was determined by subtracting the elevation at the top of a riffle at the downstream extent of the project from the elevation at the top of a riffle at the upstream end of the project (immediately below the step pools), then dividing this number by the total length of the channel between these two points, as measured along the thalweg of the stream. The measured slope, as indicated in Table 3-1, will be compared to subsequent annual monitoring data to track potential changes in the overall channel bed slope. In addition, the surveyed profile during these annual events will be plotted, overlain and compared to the baseline condition profile (Appendix C) in order to assess changes occurring in the bed structure.

Table 3-1 Channel Bed Slopes

Event	Bed Slope
Designed	0.01257*
Monitored 2004	0.01325

**Estimated based on available design drawings.*

An analysis of the surveyed longitudinal profiles reveals slight differences between the designed and monitored channel slopes. The monitored bed slope is 0.00068 steeper than the proposed design slope, which is considered minimal. When comparing the 2004 monitoring data to the proposed design profile, it seems that the riffle pool sequencing and structure placement is similar to the proposed design. This is anticipated since the intent of the proposed design was to maintain the existing bed features to the greatest extent possible.

In addition to comparing the monitored conditions to the proposed design, an analysis of the constructed project was compared to as built survey data submitted by EQR. As detailed in a March 2, 2004 memorandum from KCI to Harford County, most structures appear to be in place; however, several deviations from plan are described below. Note that descriptions are based upon the original design stationing. Stationing included in parentheses is consistent with the September 2004 survey data included in this report.

- **Boulder Bank Stabilization Sta. 5+24 to 5+97 (4+65 to 5+18)**
  As-built survey suggests downstream end of structure is approximately one foot below design elevation while the upstream end of the structure matches the proposed design elevation. Variation was not noticeable upon visual inspection while construction was in progress.

- **Boulder Spur Sta. 5+43 (5+00)**
  As-built survey reflects an 8.8% vertical slope while design calls for a 10% vertical slope.

- **Cross Vane Sta. 5+95 (5+32)**
  As-built survey suggests the structure was constructed approximately 3 feet above the proposed elevation. Although elevation appeared slightly high during placement, visual inspection during construction did not reveal any concerns regarding this structure.

- **Boulder Bank Stabilization Sta. 5+97 to 6+82 (5+22 to 6+18)**
  Entire structure appears to be approximately 2 feet above proposed elevation according to as-built survey. Visual inspection during construction did not reveal any concerns regarding this structure.

- **Boulder Spur Sta. 7+00 (6+42)**
  As-built survey reflects a 13.8% vertical slope which is significantly higher than the proposed 10% vertical slope.

- **Boulder Bank Stabilization Sta. 7+26 to 7+83 (6+65 to 7+22)**
  As-built data suggests structure is between 2-4 feet higher than proposed. Visual inspection revealed a smooth tie in with existing and no significant concerns present.

- **Boulder Bank Stabilization Sta. 7+98 to 8+60 (7+37 to 8+00)**
  Downstream end of structure is approximately 3.5 feet higher than designed while upstream end of structure matches design elevation. Visual inspection during construction did not reveal any concerns regarding this structure.

- **Boulder Spur Sta. 8+85 (8+27)**
  As-built survey reflects an 11.7% vertical slope while the proposed vertical slope is 10%.

- **Step Pool Sequence Sta. 10+06 to 10+43 - Proposed (9+75 to 9+87)**
  As-built survey shows a significant variance for three locations within the step pool sequence. The elevations for these three points match proposed although the stationing varies significantly. The proposed pool crest at station 10+00 was actually constructed at 10+06, the proposed pool bottom at station 10+22 is actually located at station 10+12 and the proposed pool crest at station 10+43 is actually located at station 10+32. Field changes were made however, they did not affect structure placement at these stations.

Although the as-built data received from EQR suggests deviation from plan, visual inspection during and post-construction did not reveal any obvious flaws in structure construction. Deviations may reflect field adjustments to conform with the actual field conditions which may have varied from those surveyed prior to design. In particular, Boulder Bank Stabilization may have been raised to a higher elevation to provide a smoother tie in with the existing bank. Some banks may have seen significant degradation from time of pre-design survey to construction and as such necessitated a higher tie-in.

In general, based on numerous visual inspections of the project site, the construction seems to be satisfactory. However, particular attention will be given to the aforementioned deviations during subsequent monitoring efforts.

As described above, cross-sectional surveys were analyzed at each of the six permanent monitoring locations to determine bankfull width, mean depth, the width/depth ratio, and overall cross-sectional area during baseline conditions. Results of the cross-sectional measurements are included in Table 3-2 and graphical depictions of each section are presented in Appendix D.

Table 3-2 Results of Cross-sectional Survey Analysis

Date Performed	Bankfull Width (ft)	Mean Depth (ft)	Width/ Depth Ratio	Cross-sectional Area (ft^2)
Station 1+70 Riffle				
September 24, 2004	19.3	13.62	6.39	2.13
Station 3+90 Riffle				
September 24, 2004	21.1	14.37	5.94	2.42
Station 4+98 Pool				
September 24, 2004	18.0	12.40	4.81	2.58
Station 6+48 Pool/Glide				
September 24, 2004	21.5	21.45	14.59	1.47
Station 7+92 Pool				
September 24, 2004	21.2	20.99	15.1	1.39
Station 8+87 Glide				
September 24, 2004	18.4	12.77	5.58	2.29

Because electronic data associated with the recommended bankfull width, mean depth, width/depth ratio and cross-sectional area from the original design were unavailable to compare to the baseline post-construction monitoring measurements above, it is being assumed that the constructed stream measurements fall within a reasonable range of tolerances to meet the intent of the design. This assumption is being made because the channel appears to be stable and functioning as initially intended. During future annual investigations, cross-sections will be measured and compared to the above baseline information and plotted sections to determine changes that may be occurring that may indicate instability in the channel.

3.1.2 Wolman Pebble Counts

The results of the pebble count data collected during the first monitoring year indicate that normal sediment transport characteristics are developing in the restored system. The average for the D_{50} for riffles was in the coarse gravels range and the D_{84} was in the small cobble range. The average D_{50} associated with the bar was in the medium gravel range and the D_{84} was in the coarse gravels range. As indicated by the data, larger particles are found in the riffle areas, which is characteristic of a natural system. Fluctuations will occur in particle size throughout the monitoring periods and are likely the result of the different sediment transport capabilities of the different flows occurring at a particular time period. These natural fluctuations will not indicate imbalances in the stream. It is important to continue to monitor particle size distributions of riffles to determine if sedimentation is occurring and affecting macroinvertebrate habitat conditions. Particle size distribution charts are included in Appendix E; the resulting values are included in Table 3-3.

Table 3-3 Result of Particle Size Analysis- Riffles/Pools

Station Identity	Mean Particle Size (mm)	
	D_{50}	D_{84}
1+70 Riffle-September 2004	25.5	71.1
6+25 Riffle-September 2004	20.5	64.6
Average Riffle-September 2004	**23.0**	**67.9**
4+75 Bar - September 2004	9.6	24.1
Average Bar-September 2004	**9.6**	**24.1**

3.1.3 General Bank and Bed Stability

During the baseline condition monitoring, bed and bank pins were established and the exposed length of each pin was measured. The bank and toe pins will be surveyed each year and compared to the baseline and previous years data. The exposed lengths of each pin are summarized in Tables 3-4 through 3-10.

Table 3-4 Bank and Toe Pin Locations - Station 4+98

Location Along Section	Bank/ Toe Pin	Elevation of Pin (Level of Exposure/Deposition) Feet (feet)
		9/24/04
0+07.2	Mid-bank	-0.12

Table 3-5 Bank and Toe Pin Locations - Station 6+10

Right/ Left Bank	Bank/ Toe Pin	Elevation of Pin (Level of Exposure/Deposition) Feet (feet)
		9/24/04
Left	Mid-bank	-0.11
Left	Toe	-0.11

Table 3-6 Bank and Toe Pin Locations - Station 6+48

Location Along Section	Bank/ Toe Pin	Elevation of Pin (Level of Exposure/Deposition) Feet (feet)
		9/24/04
0+04.8	Mid-bank	-0.19

Table 3-7 Bank and Toe Pin Locations - Station 7+25

Right/ Left Bank	Bank/ Toe Pin	Elevation of Pin (Level of Exposure/Deposition) Feet (feet)
		9/24/04
Left	Mid-bank	-0.11
Left	Toe	-0.20

Table 3-8 Bank and Toe Pin Locations - Station 7+92

Location Along Section	Bank/ Toe Pin	Elevation of Pin (Level of Exposure/Deposition) Feet (feet)
		9/24/04
0+04.8	Mid-bank	-0.10

Table 3-9 Bank and Toe Pin Locations - Station 8+57

Right/ Left Bank	Bank/ Toe Pin	Elevation of Pin (Level of Exposure/Deposition) Feet (feet)
		9/24/04
Right	Mid-bank	-0.20
Right	Toe	-0.11

Table 3-10 Bank and Toe Pin Locations - Station 8+87

Location Along Section	Bank/ Toe Pin	Elevation of Pin (Level of Exposure/Deposition) Feet (feet)
		9/24/04
0+09.3	Mid-bank	-0.10

Upon initial monitoring, it appears that stations 6+48 and 7+92 have the greatest potential of bank erosion because herbaceous vegetation has not yet become fully established. In addition to the aforementioned bank and toe pin locations, subsequent monitoring will also focus on the right bank near stations 3+09 to 3+24 and 6+70 to 7+10 where minor erosion is taking place. This area could also be susceptible to potential downcutting.

As indicated in the above tables, the pins were placed and surveyed during the initial field investigation. Because this is the first post-construction assessment, no data comparison is included in this report. Subsequent monitoring data will be compared to the aforementioned baseline conditions to evaluate erosion and depositional trends associated with the restoration project. Negative values for the measurements indicate the length of pin exposed, while positive values indicate the amount of deposition on top of the pin.

3.2 CHANNEL STABILIZATION TECHNIQUES

Channel stabilization techniques were inspected throughout the restored stream reach in September and also in early November 2004, following receipt of the full topographic survey. The topographic survey included the locations of visible portions of each of the step pools, cross vane weirs, boulder spurs, and boulder banks. KCI's Environmental Scientists walked the channel to confirm the location of each structure and to assess their functionality. The approximate locations of each structure and a description of their functionality, as assessed during the Year One monitoring efforts, is included in Table 3-11 below.

Table 3-11 Channel Stabilization Structures – September & November 2004

Station	Structure Type	Comments
0+30 LT to 69 LT	Boulder Bank	Functioning properly to protect left bank – No erosion evident.
3+15 RT	Boulder Spur	Functioning properly to protect right bank – No erosion evident.
3+15 RT to 3+51 RT	Boulder Bank	Functioning properly to protect right bank – Minor erosion evident. Some sediment deposition.
3+75 LT to 4+58 LT	Boulder Bank	Functioning properly to protect left bank – No erosion evident.
4+20 RT	Boulder Spur	Functioning properly to protect right bank – No erosion evident. Some minor downstream sediment deposition.
4+20 RT to 4+52 RT	Boulder Bank	Functioning properly to protect right bank – No erosion evident.
4+68	Cross Vane Weir	Functioning properly to protect channel grade and banks.
4+65 LT to 5+20 LT	Boulder Bank	Functioning properly to protect left bank – No erosion evident.
4+78 LT	Boulder Spur	Functioning properly to protect left bank – No erosion evident. Some sediment deposition.
5+00 RT	Boulder Spur	Functioning properly to protect left bank – No erosion evident. Some sediment deposition.
5+29	Cross Vane Weir	Functioning properly to protect channel grade and banks. Some bar formation downstream of structure. Pool developing.
5+49 RT	Boulder Spur	Functioning properly to protect right bank – No erosion evident.
5+51 RT to 5+72 RT	Boulder Bank	Functioning properly to protect right bank.
5+77 RT to 6+20 RT	Boulder Bank	Functioning properly to protect left bank.
6+25 LT to 6+70 LT	Boulder Bank	Functioning properly to protect left bank – Minor erosion evident downstream of boulder bank.
6+40 LT	Boulder Spur	Functioning properly to protect left bank – No erosion evident.
6+41 RT to 6+70 RT	Double Coir Fiber Roll	Functioning properly to protect toe of right bank, but bank bare and yard debris dumping above structure.
6+70 RT to 7+22 RT	Boulder Bank	Functioning properly to protect right bank – Minor erosion evident.
7+15 RT	Boulder Spur	Functioning properly to protect right bank – No erosion evident.
7+30 LT to 7+88 LT	Boulder Bank	Functioning properly to protect left bank – Minor erosion evident immediately downstream of boulder bank. Bar formation.
7+60 LT	Boulder Spur	Functioning properly to protect left bank – No erosion evident. Bar formation.
8+10	Cross Vane Weir	Functioning properly to protect channel grade and banks. Some upstream bar formation. Pool development.
7+99 RT to 8+51 RT	Boulder Bank	Functioning properly to protect right bank – Minor erosion evident immediately upstream of boulder bank. Bar formation.

Station	Structure Type	Comments
8+26 RT	Boulder Spur	Functioning properly to protect right bank – No erosion evident.
8+50 LT to 9+12 LT	Boulder Bank	Functioning properly to protect right and left banks – Minor erosion evident immediately upstream of boulder bank. Bar formation.
8+62 RT to 9+02 RT	Boulder Bank	Functioning properly to protect right and left banks – No erosion evident. Bar formation.
8+60 LT	Boulder Spur	Functioning properly to protect left bank – No erosion evident.
8+62 RT to 9+02 RT	Single Coir Fiber Roll	Functioning properly to protect right bank.
9+00 RT/LT	Vanes	Functioning properly to protect channel grade and banks. Originally may have been a cross vane structure, but not included on design plans.
9+20	Boulder Bed	Functioning properly to protect channel grade. Small pool developing.
9+12 LT to 11+00 LT	Large Class Riprap Bank	Functioning properly to protect right and left banks – No erosion evident.
9+25 RT to 11+00 RT	Large Class Riprap Bank	Functioning properly to protect right and left banks – No erosion evident.
10+20	Boulder Bed	Functioning properly to protect channel grade.
10+60	Boulder Bed	Functioning properly to protect channel grade.

3.3 VEGETATIVE STABILIZATION TECHNIQUES

Vegetative stabilization techniques were inspected along 50 linear foot lengths of the restored channel reach in September 2004. Data collected for the Year One baseline condition monitoring efforts is listed in Tables 3-12 and 3-13 below. Relevant comments regarding the vegetation establishment and survivability are also included in the tables and additional information assessed concerning the overall health of the vegetation, or any other evident problems within the reach are described in the discussion below.

In general, the banks appear to be stable and moderately vegetated although there are areas where vegetative establishment and/or plant survivability is less than optimal. The areal coverage along the left bank (69%) is slightly higher than the right bank (67%). Several reaches as detailed in the following tables, exhibit low areal vegetative cover that could potentially become problem areas along the channel if volunteer species do not begin to establish over time. Generally, though, even in these areas, the vegetation that was present appeared to be healthy.

Typically, bare areas along a restored streambank may be the result of any number of items, including, but not limited to: seed washing away from beneath installed erosion control fabric before becoming rooted into the soil; improper installation of seed/plants or erosion control fabric; poor quality, damaged or non-viable seed/plant materials; excessive deposition covering the vegetation; erosive velocities removing the vegetation; or, an indication of areas where the installed stream features are not functioning as intended by the designer. At this time, it is difficult to determine the causes for the lack of vegetation in areas where areal cover was lower, but it also does not appear to be a significant enough problem that it would require any immediate attention. It should be noted that the majority of the restored stream

channel is located in a relatively dense forest, so shading effects may also be delaying some of these areas from becoming well established with vegetation.

Survivability of vegetative cover along both the left and right banks is high, based on the percentages indicated in the following tables, which take into account all forms of vegetation, including permanently seeded areas, live stakes, and other riparian herbaceous, shrub and tree vegetation. Survival along the left bank (91%) is slightly better than along the right bank (85%).

Table 3-12 Vegetation Evaluation, Right Bank – September 2004

Right Bank Station	Percent Areal Vegetation Coverage on Banks	Percent Survivability of Vegetative Cover	Comments
Culvert to 0+00	35	80	Little vegetation on banks
0+00 to 0+50	40	20	Little vegetation on banks
0+50 to 1+00	100	100	
1+00 to 1+50	60	100	Rocks placed by property owner for bank stabilization
1+50 to 2+00	100	100	
2+00 to 2+50	85	95	
2+50 to 3+00	85	95	
3+00 to 3+50	25	30	2 live stakes apparently dead/no herbaceous vegetation
3+50 to 4+00	15	100	No herbaceous vegetation
Right Bank Station	**Percent Areal Vegetation Coverage on Banks**	**Percent Survivability of Vegetative Cover**	**Comments**
4+00 to 4+50	15	90	Live stakes not well-established/1 unhealthy oak
4+50 to 5+00	85	90	4 live stakes apparently dead
5+00 to 5+50	85	95	
5+50 to 6+00	75	95	Sparse vegetation
6+00 to 6+50	15	20	No herbaceous vegetation
6+50 to 7+00	30	90	Exposed steep bank
7+00 to 7+50	85	90	2 live stakes apparently dead
7+50 to 8+00	90	100	Jewelweed uprooted
8+00 to 8+50	10	80	5 live stakes apparently dead
8+50 to 9+00	90	95	
9+00 to 9+50	95	100	
9+50 to 10+00	100	95	
10+00 to 10+50	100	95	
10+50 to 11+00	90	95	
11+00 to 11+04	100	100	
Averages	**67%**	**85%**	

Table 3-13 Vegetation Evaluation, Left Bank – September 2004

Left Bank Station	Percent Areal Vegetation Coverage on Banks	Percent Survivability of Vegetative Cover	Comments
Culvert to 0+00	40	100	Little vegetation on banks
0+00 to 0+50	35	100	Little vegetation on banks
0+50 to 1+00	75	90	
1+00 to 1+50	80	100	
1+50 to 2+00	95	100	
2+00 to 2+50	90	90	Dead/dormant herbaceous vegetation
2+50 to 3+00	90	90	
3+00 to 3+50	60	60	Dead/dormant herbaceous vegetation
3+50 to 4+00	30	50	
4+00 to 4+50	60	90	Live stakes not well established
4+50 to 5+00	65	90	1 unhealthy oak
5+00 to 5+50	85	95	4 live stakes not well established/ tree cut down @ ~5+50
5+50 to 6+00	85	90	Exposed banks
6+00 to 6+50	15	100	Exposed banks
6+50 to 7+00	40	95	Limited sunlight
7+00 to 7+50	75	90	Limited sunlight
7+50 to 8+00	15	100	
8+00 to 8+50	25	90	
8+50 to 9+00	95	100	
9+00 to 9+50	100	100	Well vegetated yards
9+50 to 10+00	100	95	Well vegetated yards
10+00 to 10+50	100	90	Well vegetated yards
10+50 to 11+00	100	95	Well vegetated yards
11+00 to 11+04	100	95	Well vegetated yards
Averages	**69%**	**91%**	

When considering just the bioengineering materials installed as part of the restoration effort, in general, the live stakes appeared to be in relatively satisfactory condition throughout much of the reach. However, as detailed in the above table, sporadic problems associated with live stake establishment are occurring. Success of live staking is dependent on many factors including: viability of the planted materials (live stakes dry out quickly if not kept in cool moist areas); the season in which they are harvested and installed (must be dormant plants); the degree of shading and shade tolerance of the plants; the procedures used during installation (proper backfilling of holes and cutting off of damaged ends), and the amount of water delivered to root zones, just to name a few. The cause for the minimal success in these particular areas could not be ascertained from the inspections. Further monitoring will be done during subsequent years to track the development of the live stakes, spread of materials from successful live stakes, and to determine if further plantings will be necessary to fully stabilize the banks.

In addition, other areas of concern include the banks between stations 0+00 and 1+00, where vegetation has not become fully established. Also, slight erosion is occurring along the toe of the left bank, at stations 5+50 to 6+25 and 7+14 to 7+39 due to the lack of established vegetation. Grass clippings and yard waste dumped on the banks may be impeding vegetation growth in some of these areas, including the top of bank between stations 6+20 to 6+55. In addition, two oak plantings located within the right

floodplain area between stations 4+00 to 4+50 and 4+50 to 5+00 appear unhealthy. Another sapling on the left bank between stations 5+00 to 5+50 was cut down.

3.4 MACROINVERTEBRATE MONITORING RESULTS

Pre-construction Monitoring

In September 1998, KCI, under contract with the Harford County Department of Public Works, conducted a macroinvertebrate analysis and habitat assessment as part of the Engineering Study for Bynum Run Watershed (KCI Technologies, 1999). Maryland Save Our Streams (SOS) Project Heartbeat protocol was used. The results of this one-time assessment event are provided in Tables 1 and 3 of Appendix F.

Beginning Spring 2000, SOS, under contract with Harford County, conducted macroinvertebrate sampling and habitat assessments using the Project Heartbeat Protocol. Raw macroinvertebrate data was lost when SOS ceased operations, so only the biological scores are available for the Spring 2000 sampling period. In addition, samples that were collected by Save Our Streams in Spring and Fall 2001 were never analyzed by SOS. The samples were eventually located and were analyzed by the DNR, Monitoring and Nontidal Assessment Division, Resource Assessment Service. Raw data results are presented in Appendix F

Macroinvertebrate samples collected in Spring 2002 at station HAR006 and in Fall 2002 at station HAR007 had insufficient number of organisms to calculate metrics using either the Project Heartbeat protocol or the Maryland Biological Stream Survey (MBSS) protocol. The Fall 2002 samples collected at station HAR006 had sufficient number of individuals to calculate a biological score using Project Heartbeat protocol, but not for calculating an Index of Biological Integrity (IBI) using MBSS protocol. The metrics from the sample collected at station HAR006 in Fall 2002 are provided in Appendix F.

Beginning Summer 2003, DNR, began collecting and analyzing the macroinvertebrate samples in Box Hill. IBI data for Summer 2003 and Spring 2004 are also presented in Appendix F.

Overall, pre-construction monitoring was sporadic and the methodology was inconsistent. However, regardless of the protocol used, all indices indicate that the macroinvertebrate community was highly impacted as a result of uncontrolled stormwater runoff and excessive bank erosion.

Post-Construction Monitoring

To date, post-construction monitoring has involved one sampling period. Because of the limited time period between the completion of the construction activities and the sampling, little or no changes to the macroinvertebrate communities were expected. As detailed in Appendix F, data indicate a very poor macroninvertebrate community. As the habitat conditions improve over time (vegetation establishment, riffle/pool sequencing, etc.) the macroinvertebrate populations are expected to improve. Sampling will continue to track these changes.

4.0 CONCLUSION

The Harford County Department of Public Works, Water Resources Engineering Division requested KCI to perform stream monitoring to fulfill permitting requirements associated with the Box Hill – South Tributary restoration project. Restoration efforts involved the installation of various instream structures, including step pools, boulder spurs, cross vane weirs, boulder bank stabilization and coir fiber rolls. In addition, the entire site was planted with native trees, shrubs and live stakes.

To adequately assess the success of the project, a monitoring plan was developed that involves fluvial geomorphic, biological, structure stability, and vegetation monitoring. To date, the fluvial geomorphic monitoring results and visual observations suggest that the site is stable. As detailed previously, the 2004 monitored bankfull width, mean depth, width/depth ratio and cross-sectional area could not be compared to the original design because the design data were unavailable. However, it is assumed that the constructed stream measurements fall within a reasonable range of tolerances to meet the intent of the design because the baseline condition topography is similar to the proposed design plans and because the channel appears to be stable and functioning as initially intended.

Based on visual field observations, all installed structures are functioning in accordance with their associated design goals and objectives, and are providing bank protection, grade control, and habitat creation. Several minor areas of erosion were evident at various boulder banks, and these areas will be monitored each year to assess whether the problem continues to occur,

In general, the banks appear to be stable with moderate vegetation growth throughout the site. However, as presented in Section 3.3, the percent of vegetative coverage is somewhat low and is most likely due to seasonal growth patterns and the limited time the vegetation has been in the ground. In addition, yard clippings are being deposited in some locations, which may be limiting vegetative establishment. Overall, the vegetation that is present is healthy. Live stakes are showing adequate growth in most locations and will be evaluated further during future monitoring events.

To date, post-construction macroinvertebrate sampling has only included one sampling event. Because of the limited time period between the completion of the construction activities and the sampling, little or no changes to the macroinvertebrate communities are expected. As detailed previously, data indicate a very poor macroninvertebrate community. As the habitat conditions improve over time (vegetation establishment, riffle/pool sequencing, etc.), the macroinvertebrate populations are expected to improve. Sampling will continue to track these changes.

Based on the Year One monitoring efforts, it appears that the goals of the project, including improved stability, pool/riffle formation, reduced embeddedness and sedimentation, and overall improved aquatic and riparian habitat quality are being achieved. Installed structures are providing bed and bank stabilization and habitat creation. In addition, vegetation, for the most part, is becoming established and is healthy.

Because this is the first year of post-construction monitoring, conditions could change based on vegetation growth, sediment transport, and overall bank stability, as well as potential major flooding or catastrophic events. Subsequent monitoring will occur over the next 4 years to track the stability of the restored stream and any changes that occur within the channel. Post-construction monitoring reports for subsequent monitoring years will be prepared and submitted annually at the end of each year. The reports will only include the data collected, results and discussion section that compare the yearly results to the baseline information and previous years monitoring events, and a conclusions section summarizing whether or not the stream restoration project is continuing to meet the project goals.

5.0 REFERENCES

Harrelson, C.C., Rawlins, C.L. and J.P. Potyondy. 1994. *Stream Channel Reference Sites: An Illustrated Guide to Field Technique. General Technical Report RM-245*. United States Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Leopold, L. B., M.G. Wolman and J.P. Miller. 1964. Fluvial Processes in Geomorphology. Freeman, San Francisco, CA.

Wolman, M.G. 1954. *A Method of Sampling Coarse River-Bed Material*. Transactions of the American Geophysical Union, 35: 951-956.

APPENDIX A

SITE PHOTOGRAPHS

Photo ID 1 - Station 1+70, facing upstream, September 2004

Photo ID 2 – Station 1+70, facing downstream, September 2004

Photo ID 3 – Station 3+09 to 3+24, minor down-cutting of the channel bed, September 2004
Note exposed footer rock

Photo ID 4 – Station 3+90, facing upstream, September 2004

Photo ID 5 – Station 3+90, facing downstream, September 2004

Photo ID 6 – Station 4+98, right bank facing upstream, September 2004

Photo ID 7 – Station 4+98 left bank facing upstream, September 2004

Photo ID 8 – Station 4+98, facing downstream, September 2004

Photo ID 9 – Station 4+98, facing downstream, September 2004

Photo ID 10 – Stations 5+50 to 6+25, facing downstream, September 2004
Note erosion at toe of bank

Photo ID 11 - Stations 5+50 to 6+25, facing downstream, September 2004
Note erosion of bank

Photo ID 12 - Stations 5+50 to 6+25, facing downstream, September 2004
Note erosion of bank

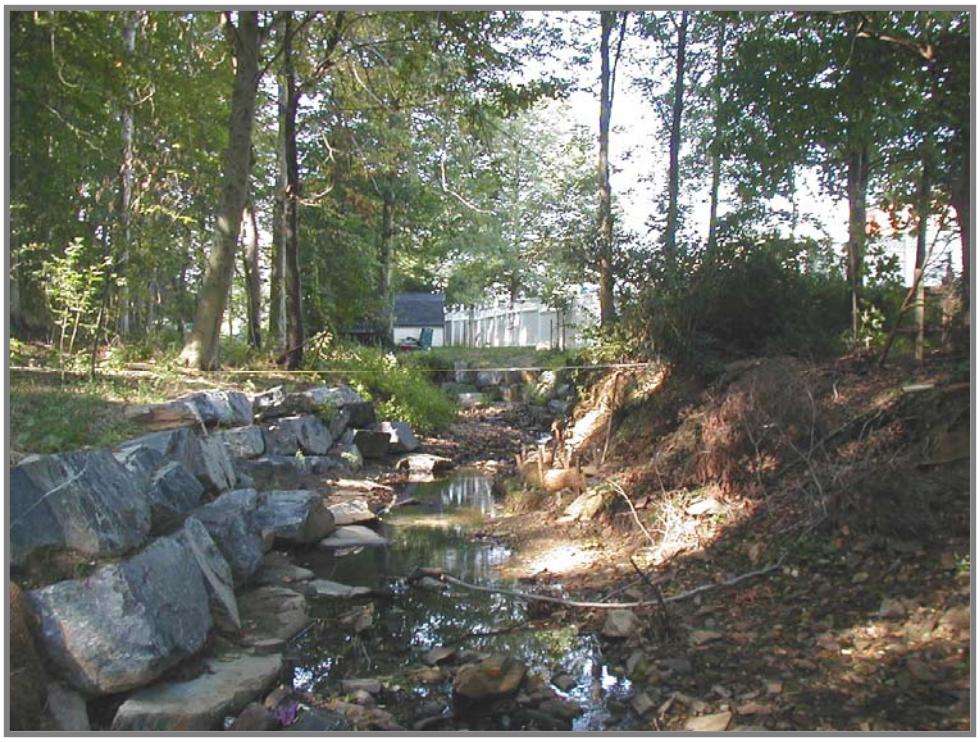


Photo ID 13 – Station 6+48, facing upstream, September 2004

Photo ID 14 – Station 6+48, facing downstream, September 2004

Photo ID 15 – Station 6+48, right bank, September 2004
Note yard debris and bare bank

Photo ID 16 – Station 6+20 to 6+55, right bank facing upstream, September 2004
Note exposed bank/roots drainage pipes

Photo ID 17 – Stations 6+70 to 7+10, minor down-cutting
of the channel bed, facing downstream, September 2004

Photo ID 18 – Stations 7+14 to 7+39, facing downstream,
September 2004
Note exposed bank/roots

Photo ID 19 – Station 7+92, facing upstream, September 2004

Photo ID 20 – Station 7+92, facing downstream, September 2004

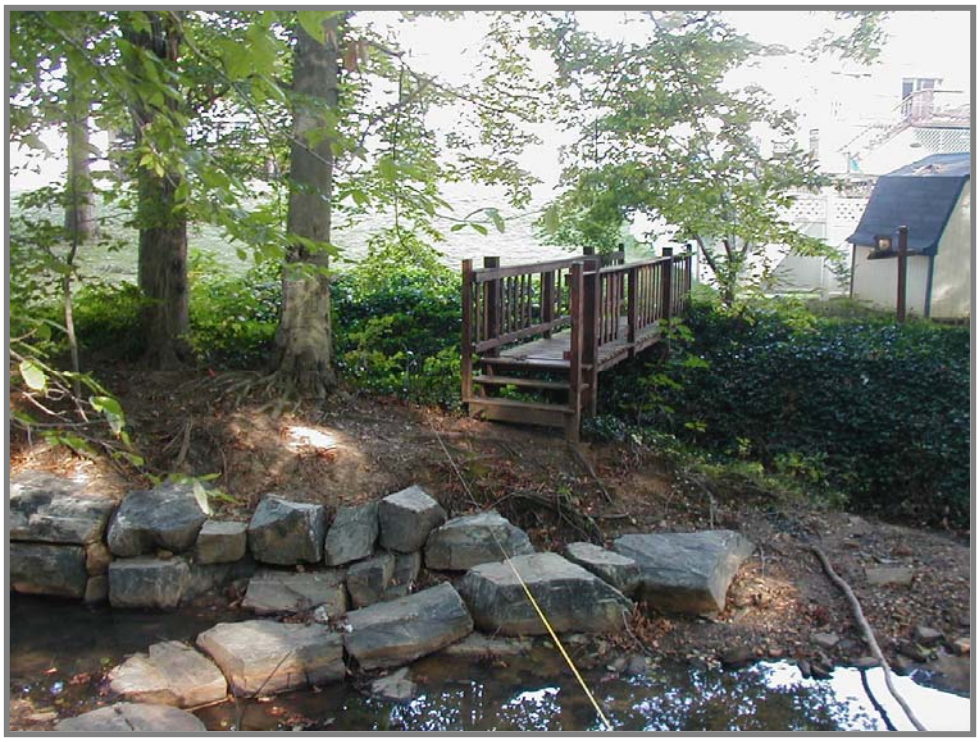


Photo ID 21 – Station 7+92, right bank, September 2004
Note exposed right bank/minimal vegetation

Photo ID 22 - Station 7+92, left bank, September 2004
Note exposed left bank/minimal vegetation

Photo ID 23 – Station 8+87, right bank facing upstream, September 2004

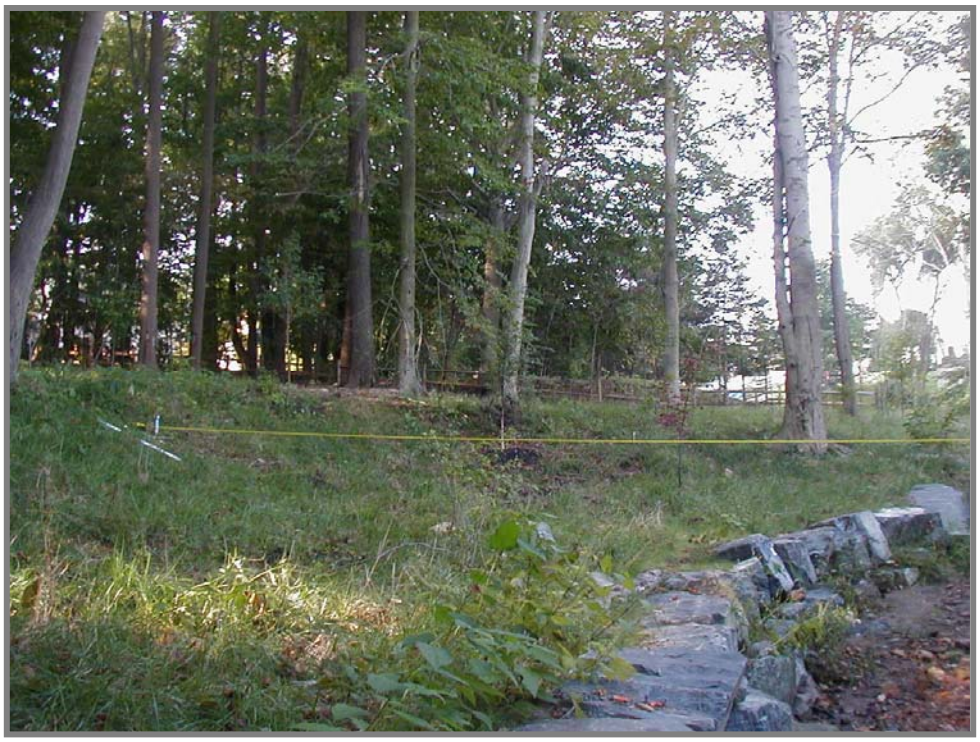


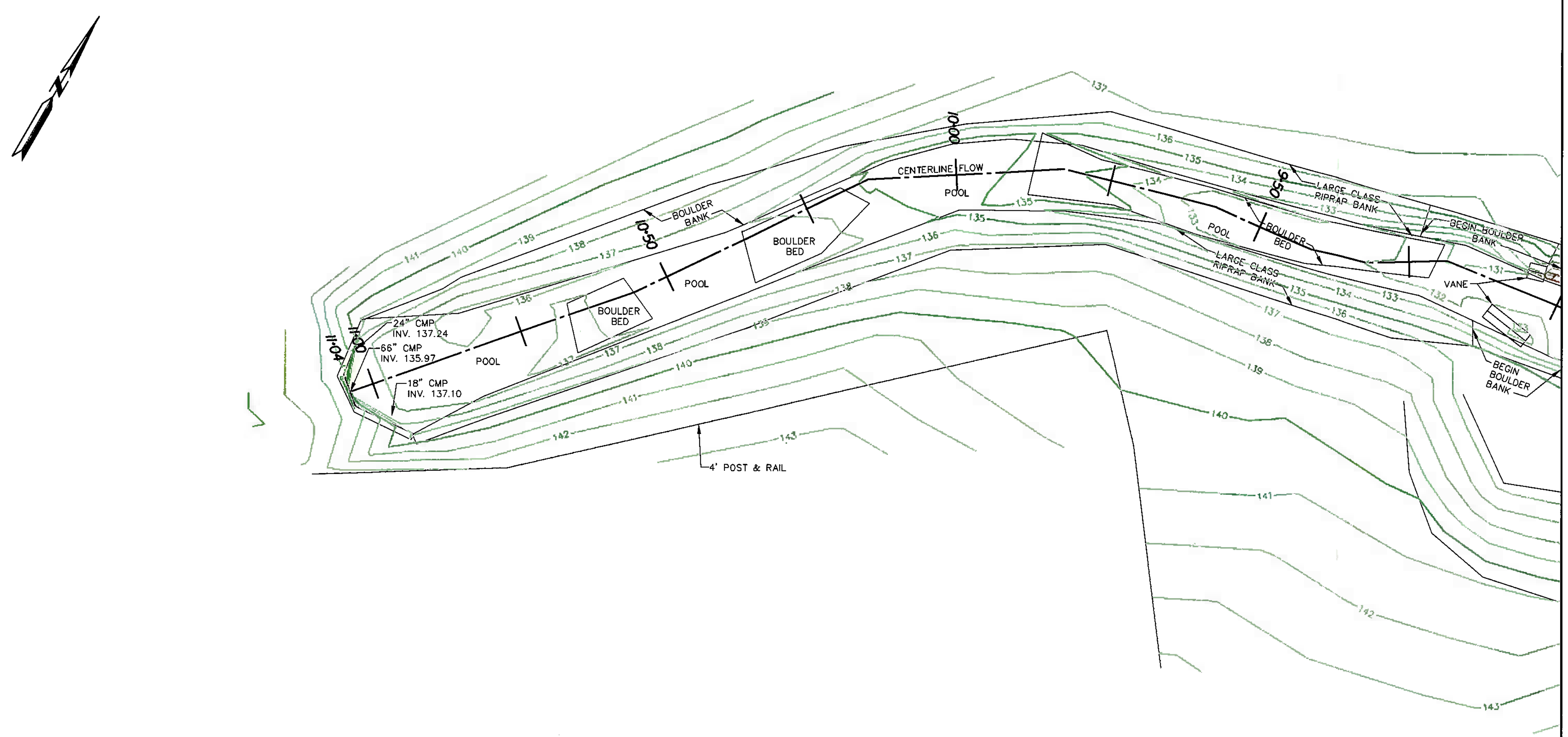
Photo ID 24 – Station 8+87, left bank facing upstream, September 2004

Photo ID 25 – Station 8+87, facing downstream, September 2004

Photo ID 26 – Station 8+87, facing downstream, September 2004

APPENDIX B

BASELNE CONDITION TOPOGRAPHIC MAPPING



SEE MATCH LINE

LEGEND

CONTOURS

TRAFFIC/TRANS.	CH. W/S ENG.
SED. CONTROL	ASSESSMENTS
W/S CONST.	MAINT/OP
H-WAY CONST. PERMITS	DESIGN
LAND ACQUISITION	ENG. SYS. BR.

ENGINEER'S SEAL

DATE	REVISION	BY

DRAWING COMPLETED

HARFORD COUNTY MARYLAND

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POST – CONSTRUCTION SURVEY

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TRACED

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SCALE NTS APPROX. SCALE 1" = 20'

TAX MAP

POSITION SHEET

SHEET NO. ______ OF ______

J.O. ______

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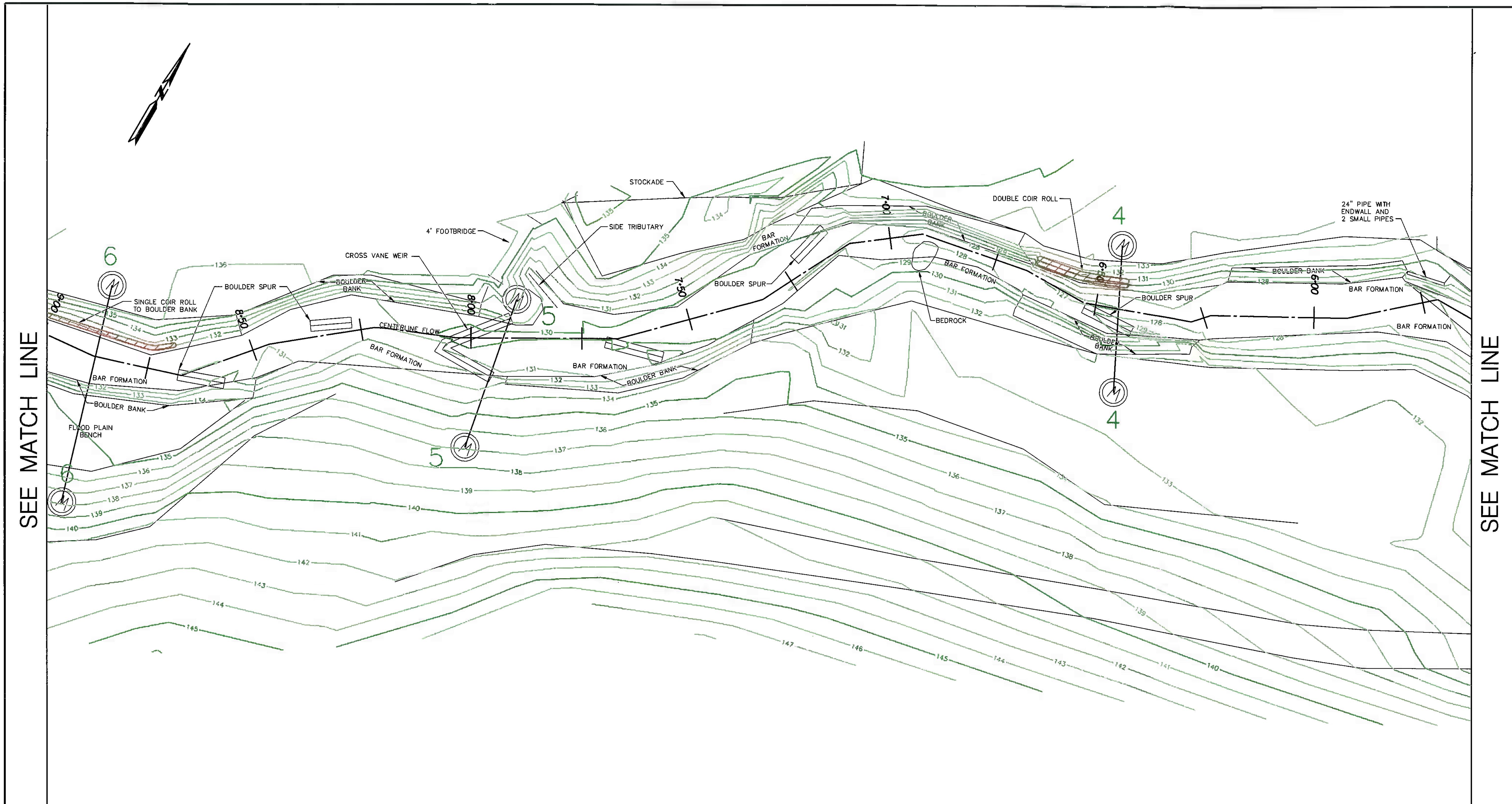

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ENGINEER'S SEAL

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SED. CONTROL	ASSESSMENTS
W/S CONST.	MAINT/OP
H-WAY CONST. PERMITS	DESIGN
LAND ACQUISITION	ENG. SYS. BR.

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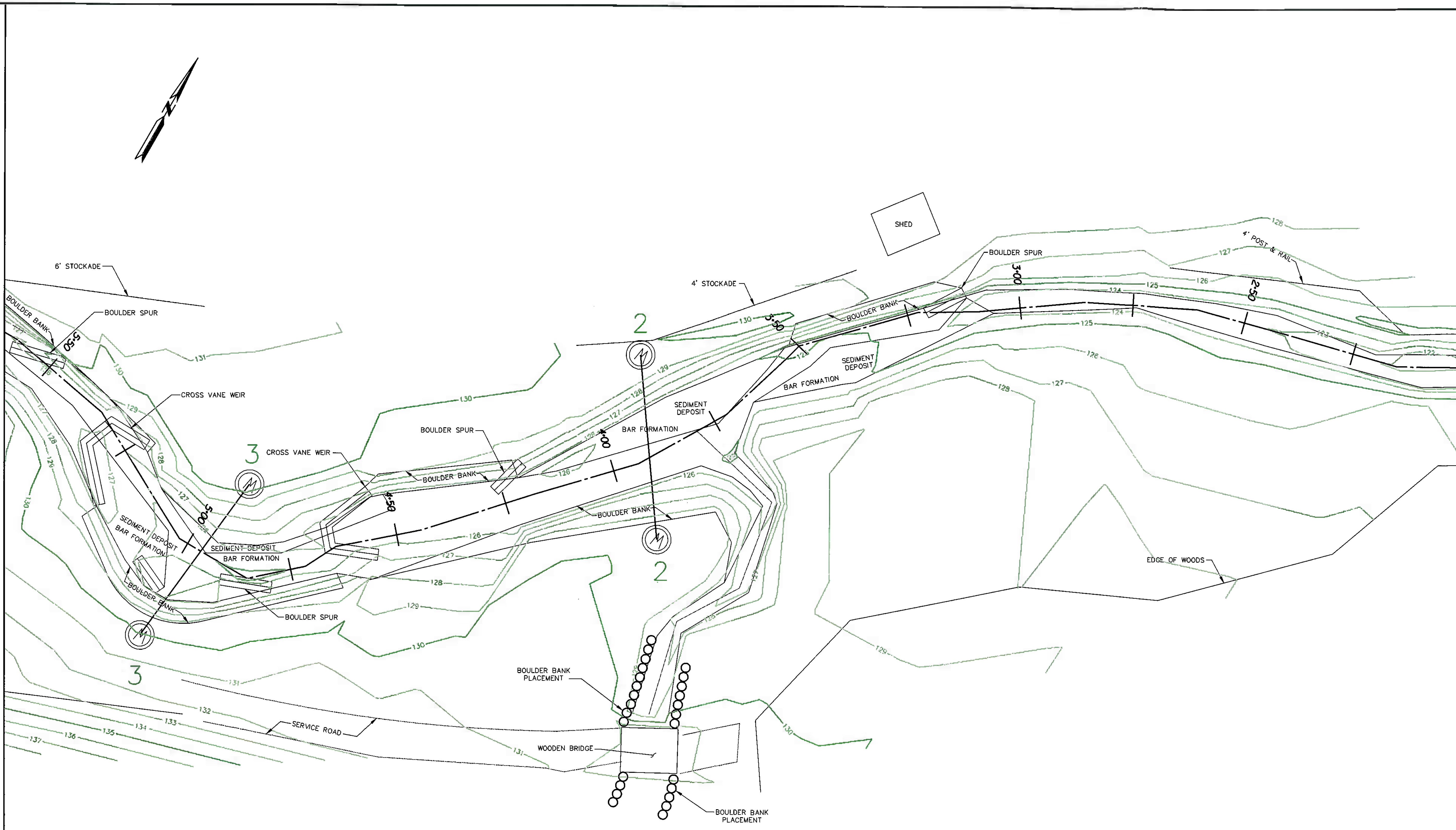

SEE MATCH LINE

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CONTOURS

ENGINEER'S SEAL

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SED. CONTROL	ASSESSMENTS
W/S CONST.	MAINT/OP
H-WAY CONST. PERMITS	DESIGN
LAND ACQUISITION	ENG. SYS. BR.

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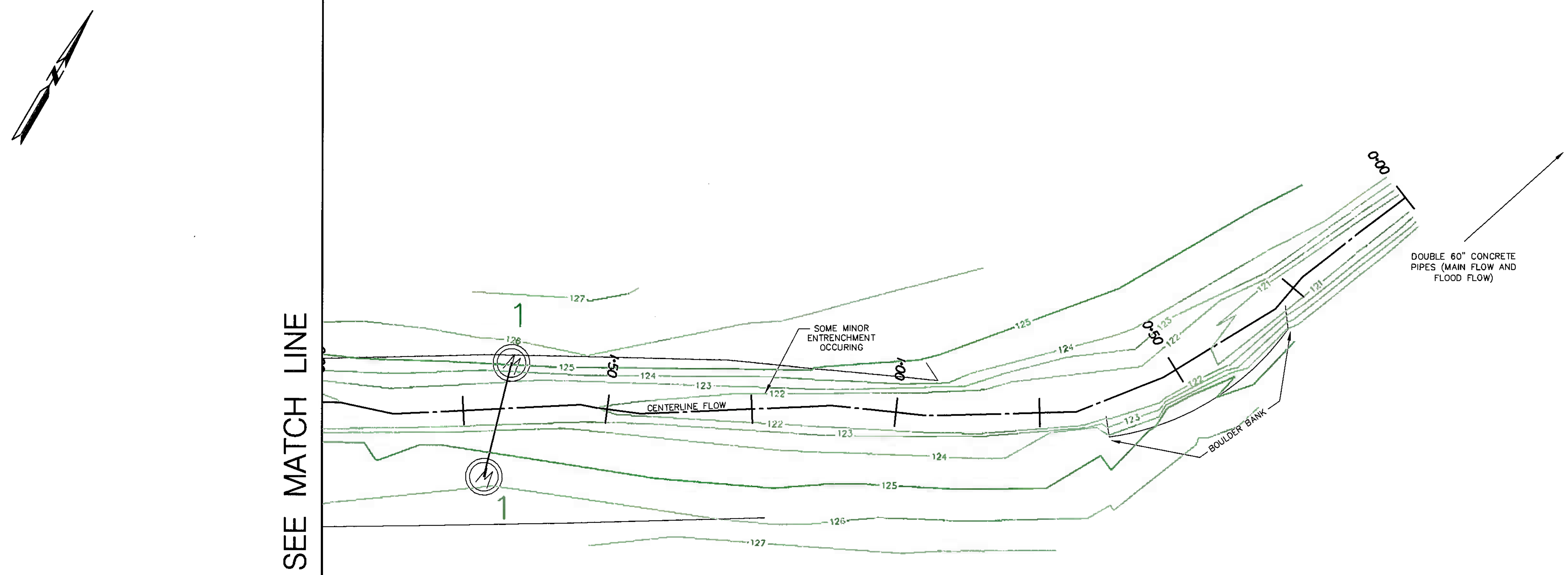

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CONTOURS

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SED. CONTROL	ASSESSMENTS
W/S CONST.	MAINT/OP
H-WAY CONST. PERMITS	DESIGN
LAND ACQUISITION	ENG. SYS. BR.

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DATE	REVISION	BY

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TAX MAP

POSITION SHEET

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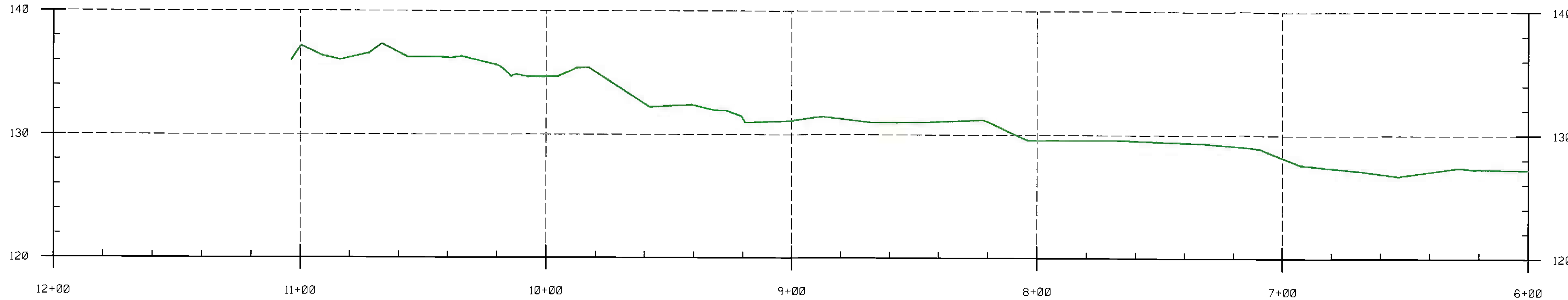
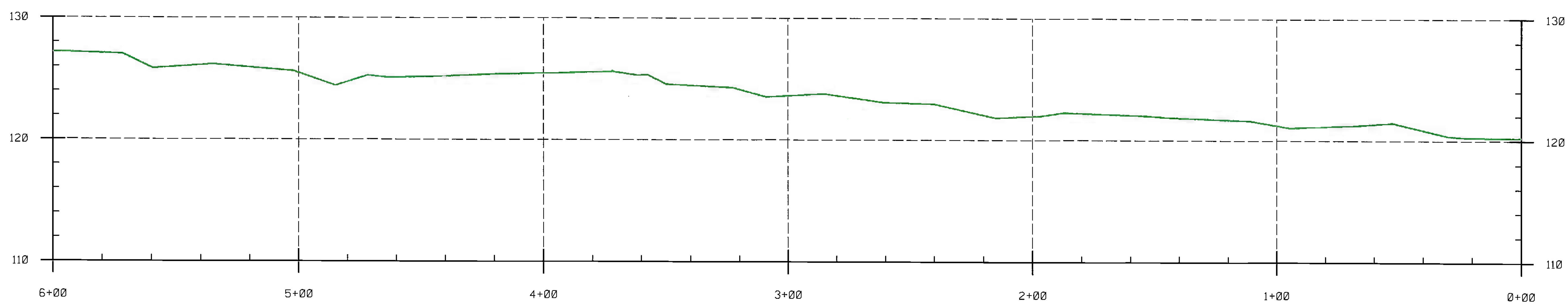
APPENDIX C

LONGITUDINAL PROFILE SURVEY DATA





LEGEND

AS-BUILT GRADE

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SED. CONTROL	ASSESSMENTS
W/S CONST.	MAINT/OP
H-WAY CONST. PERMITS	DESIGN
LAND ACQUISITION	ENG. SYS. BR.

ENGINEER'S SEAL

DATE	REVISION	BY

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SCALE NTS APPROX. SCALE HOR. 1"= 40' VERT. 1"= 8'

TAX MAP

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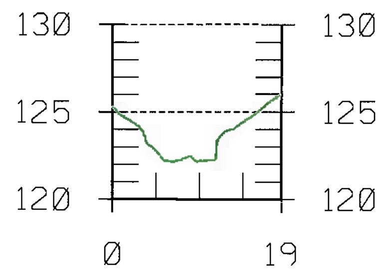
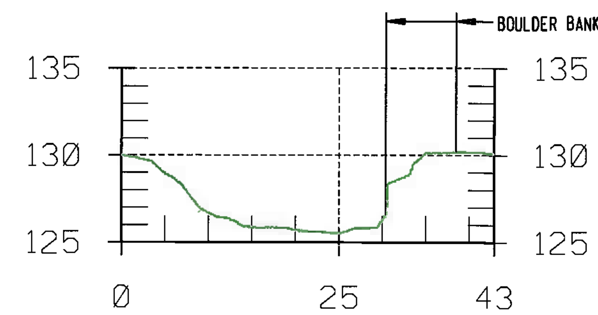
APPENDIX D

CROSS SECTIONAL SURVEY DATA



SECTION 1-1



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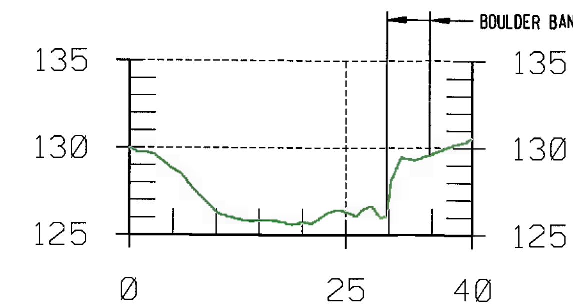
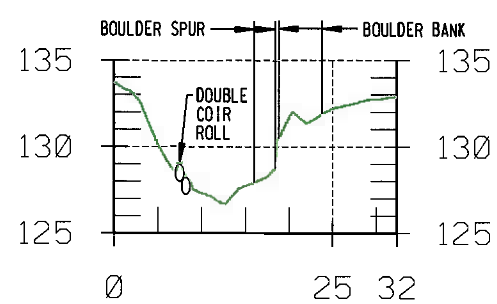
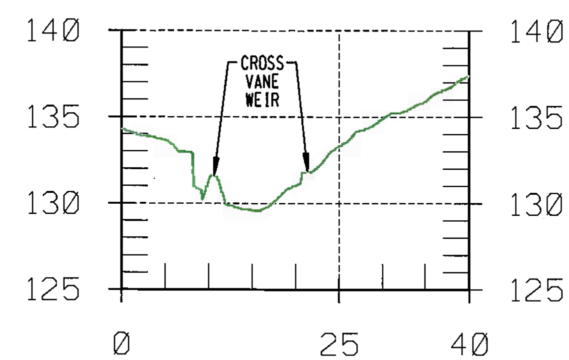


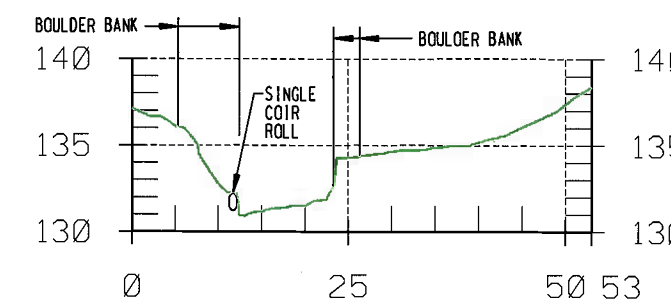
SECTION 3-3



SECTION 4-4



SECTION 5-5



SECTION 6-6

NOTE: CROSS SECTIONS SHOWN LEFT TO RIGHT FACING DOWNSTREAM

LEGEND

AS-BUILT GRADE

ENGINEER'S SEAL

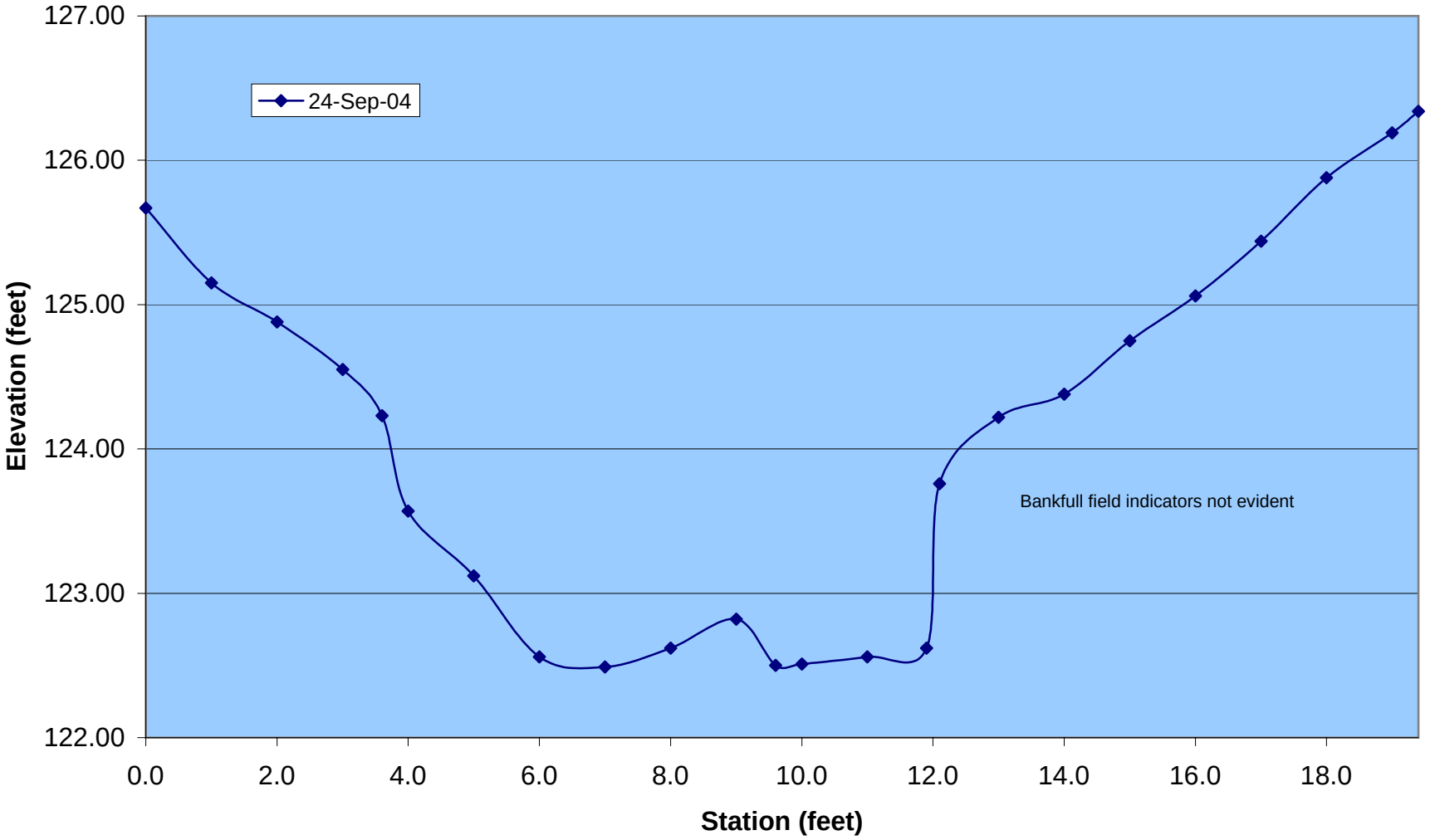
TRAFFIC/TRANS.	CH. W/S ENG.
SED. CONTROL	ASSESSMENTS
W/S CONST.	MAINT/OP
H-WAY CONST. PERMITS	DESIGN
LAND ACQUISITION	ENG. SYS. BR.

DATE	REVISION	BY

DRAWING COMPLETED

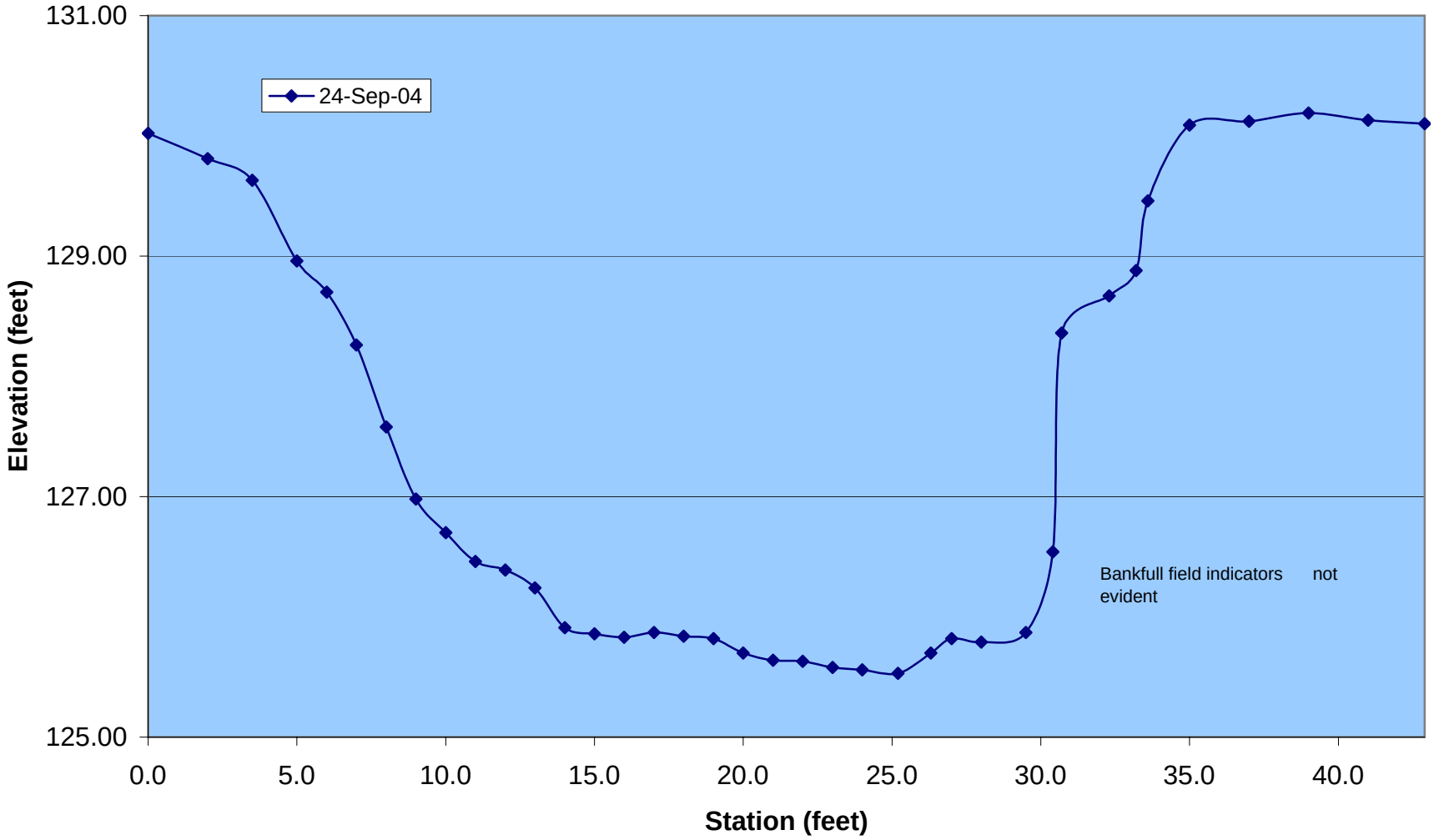
HARFORD COUNTY MARYLAND	HARFORD COUNTY DIRECTOR OF PUBLIC WORKS Date	HARFORD COUNTY DEPUTY DIRECTOR, WATER RESOURCES ENGINEERING Date	DEPARTMENT OF PUBLIC WORKS WATER RESOURCES ENGINEERING	BOXHILL TRIBUTARY BASELINE POST - CONSTRUCTION CROSS SECTIONS	KCI TECHNOLOGIES Engineers Planners Scientists Construction Managers 10 North Park Drive Hunt Valley, MD 21030 Phone (410) 316-7800 Fax (410) 316-7817 www.kci.com	DESIGNED TRACED CHECKED	SCALE NTS APPROX. SCALE HOR. 1"= 20' VERT. 1"= 10'	TAX MAP POSITION SHEET	SHEET NO. OF	J.O. FILES

Box Hill, Harford County
Riffle
Cross-Section 1 @ Station 1+70



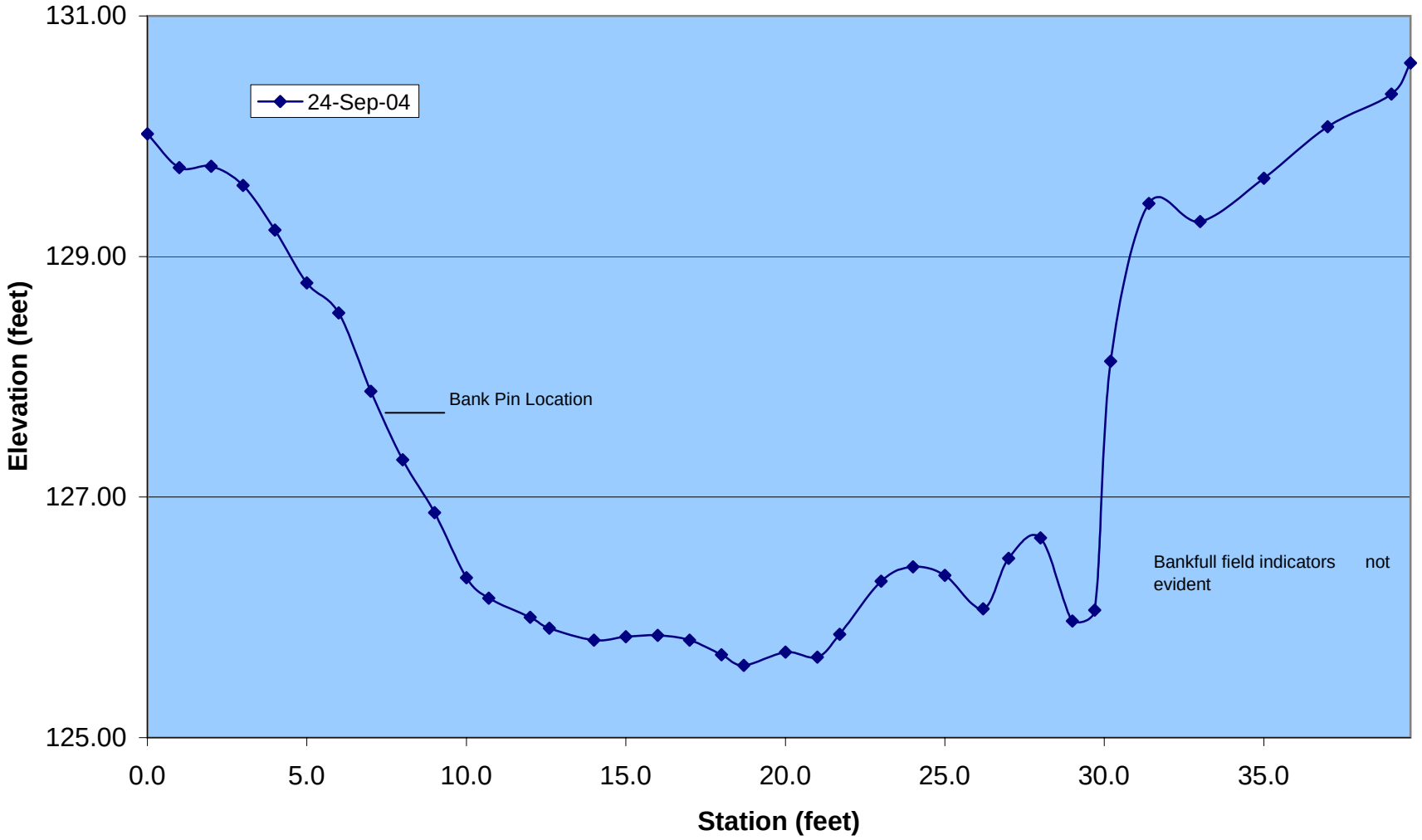
Note - Cross sections are left to right facing downstream

Box Hill, Harford County
Glide
Cross-Section 2 @ Station 3+90



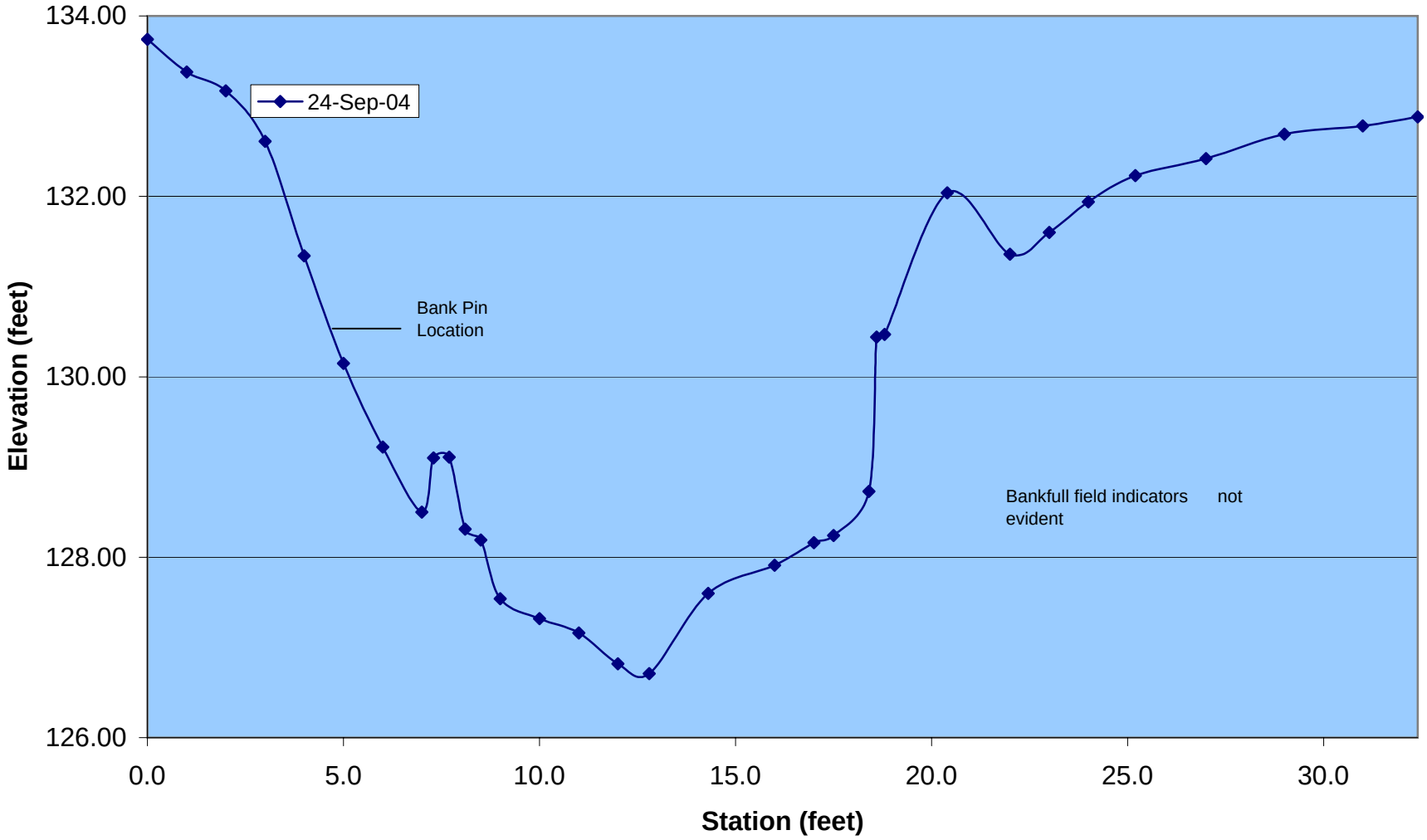
Note - Cross sections are left to right facinf downstream

Box Hill, Harford County
Riffle
Cross-Section 3 @ Station 4+98



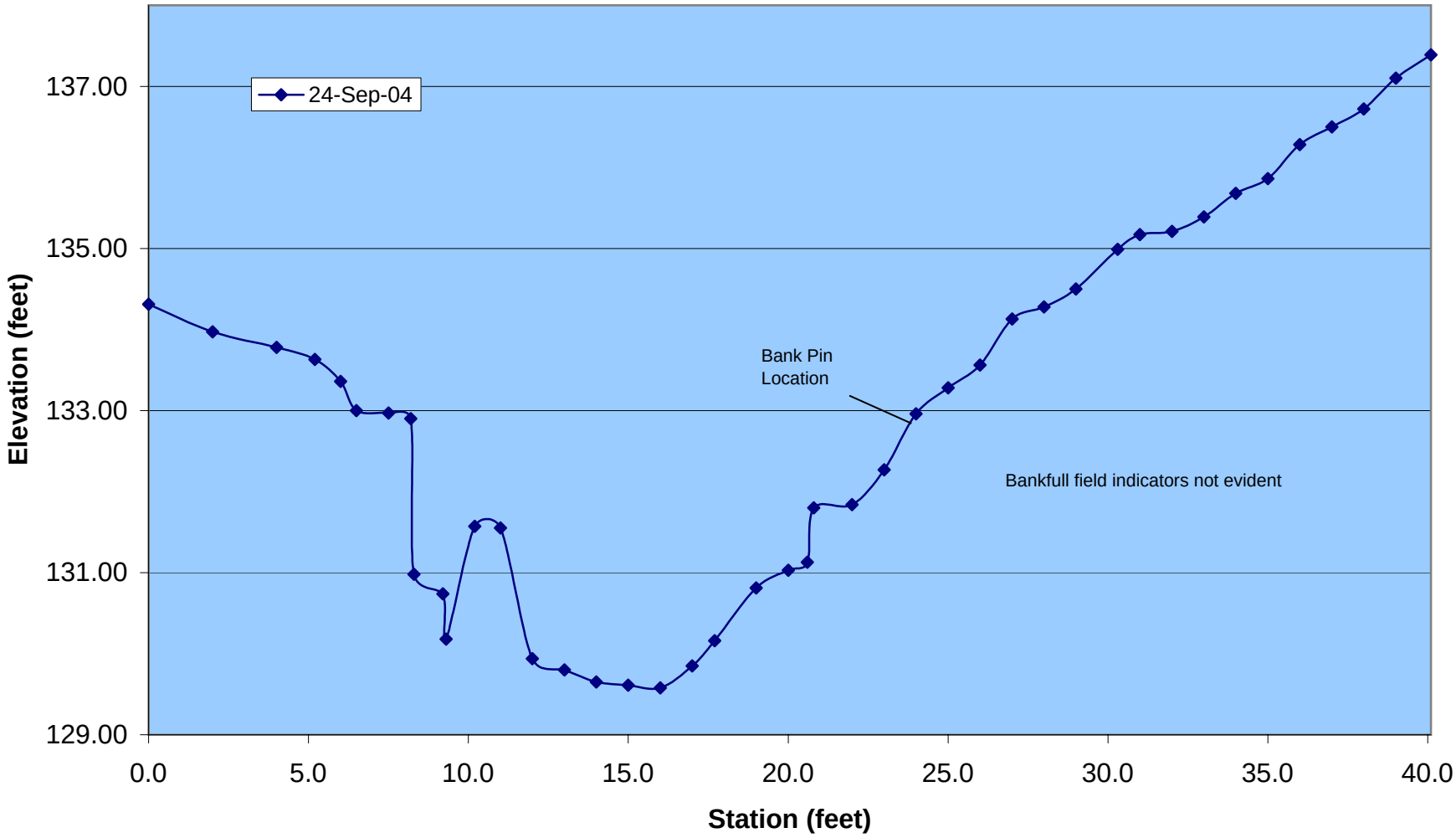
Note - Cross sections are left to right facing downstrream

Box Hill, Harford County
Pool
Cross-Section 4 @ Station 6+48



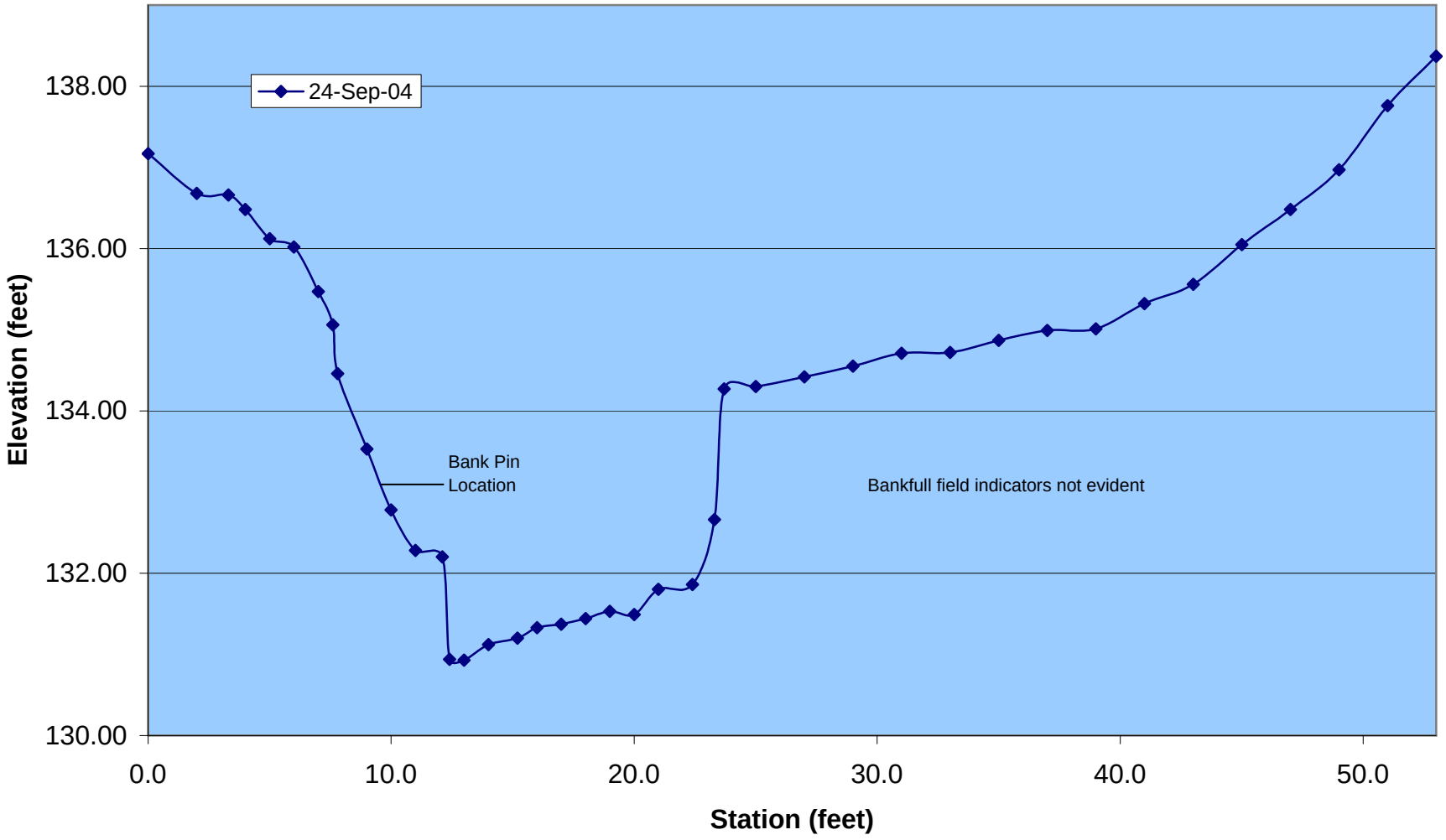
Note - Cross sections are left to right facing downstream

Box Hill, Harford County
Pool
Cross-Section 5 @ Station 7+92



Note - Cross sections are left to right facing downstream

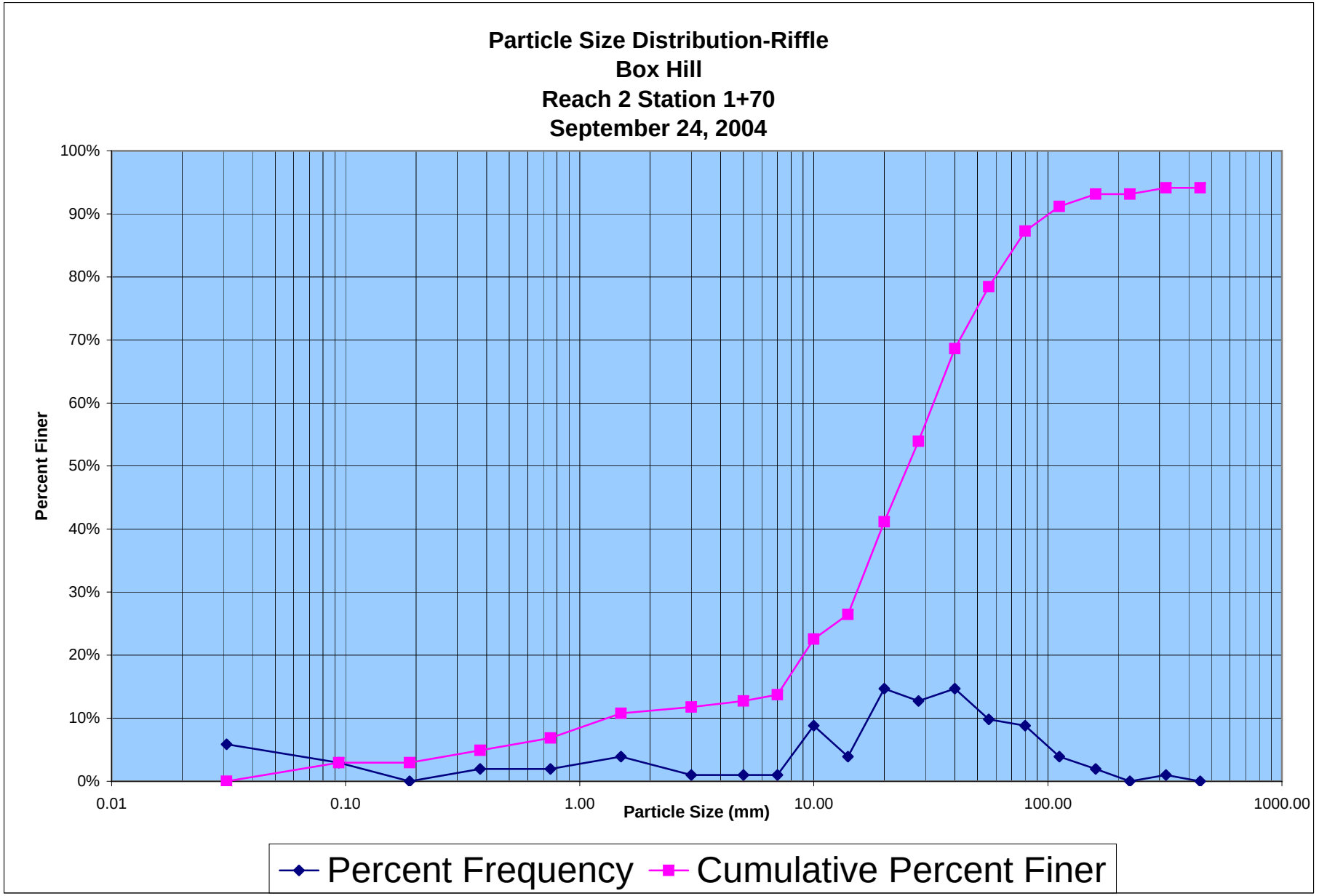
Box Hill, Harford County
Riffle
Cross-Section 6 @ Station 8+87

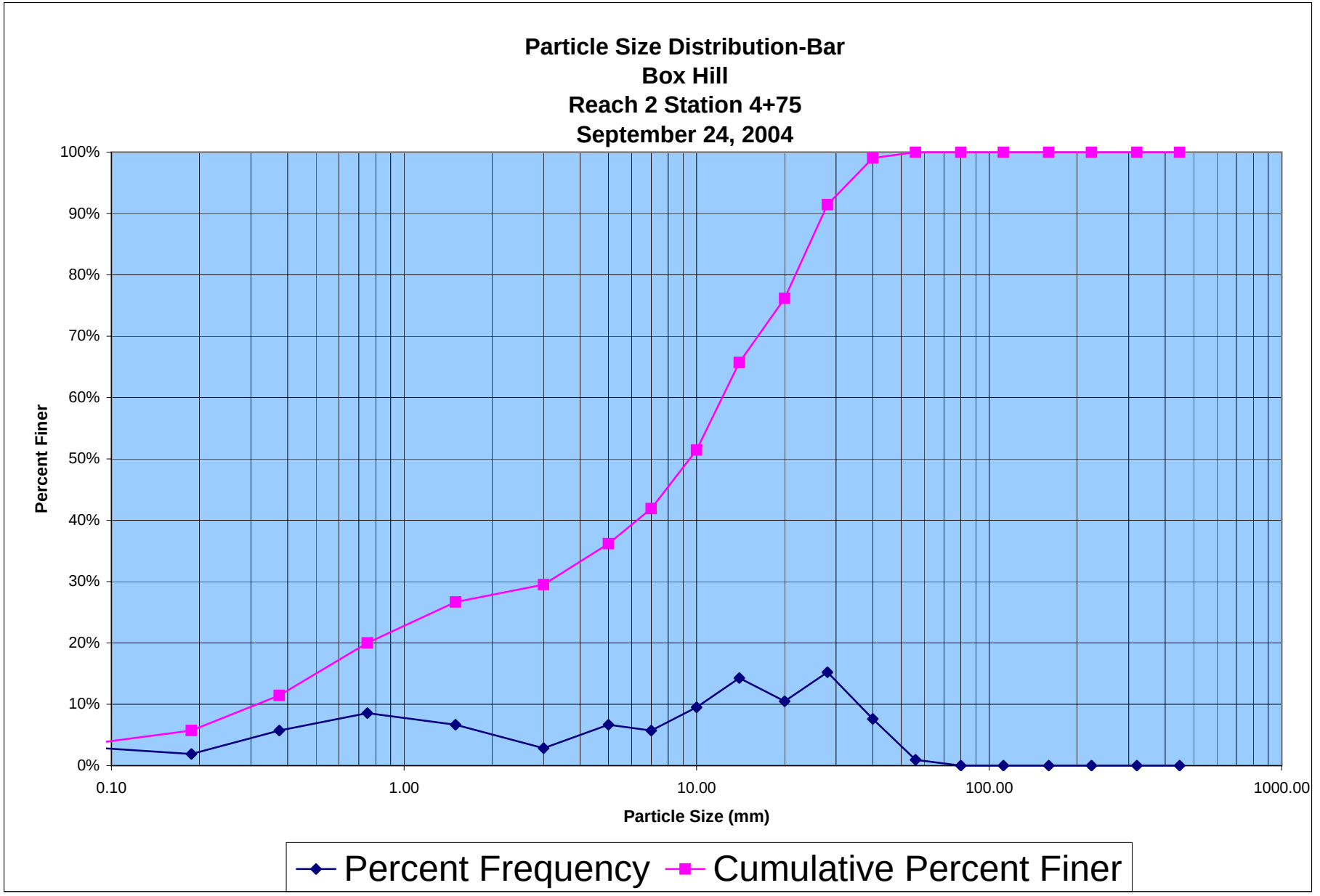


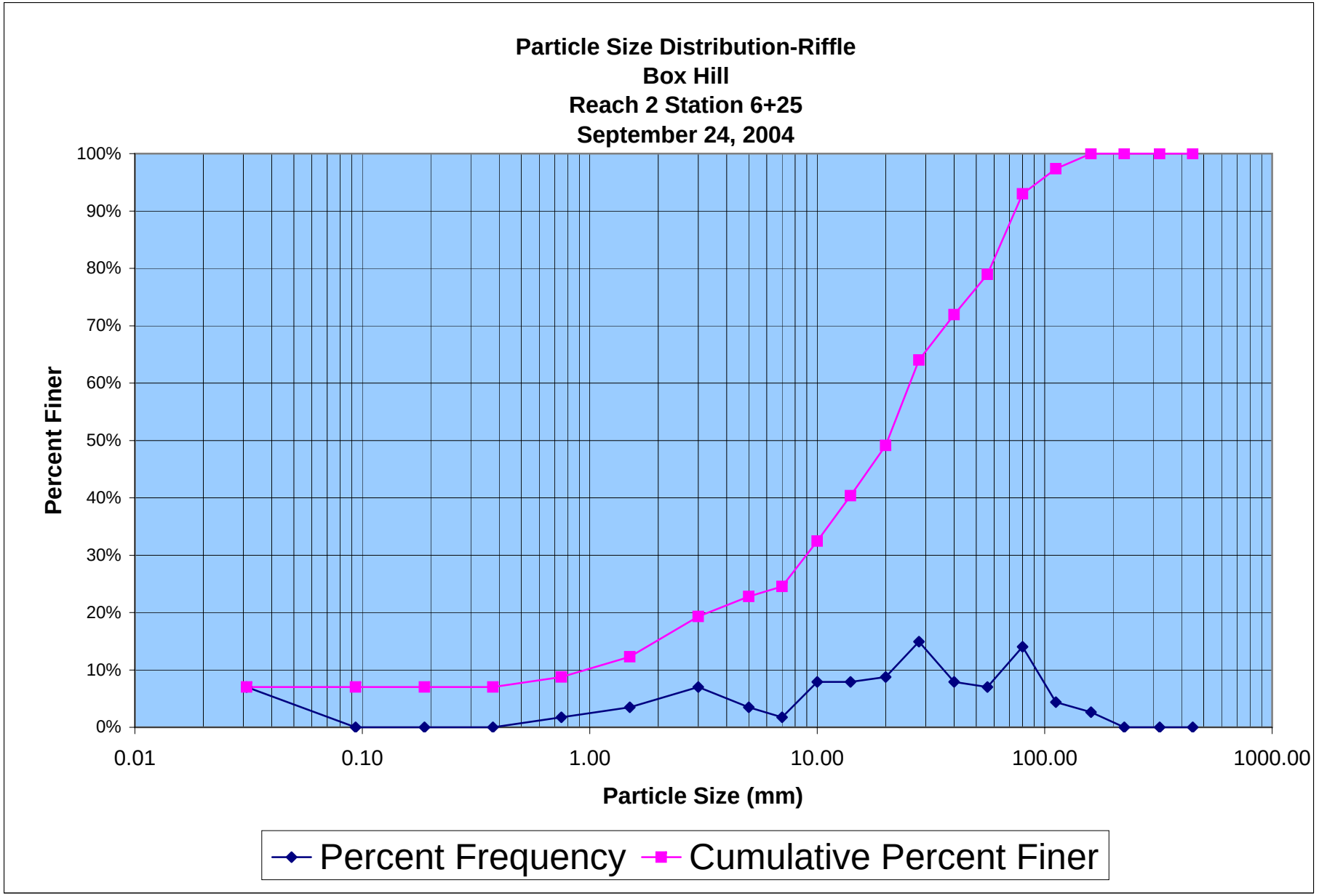
Note - Cross sections are left to right facing downstream

APPENDIX E

PEBBLE COUNT DATA


Particle Size Distribution-Riffle
Box Hill
Reach 2 Station 1+70
September 24, 2004
Percent Finer
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.10
1.00
10.00
100.00
1000.00
Particle Size (mm)
Percent Frequency
Cumulative Percent Finer


Particle Size Distribution-Bar
Box Hill
Reach 2 Station 4+75
September 24, 2004
Percent Finer
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.10
1.00
10.00
100.00
1000.00
Particle Size (mm)
Percent Frequency
Cumulative Percent Finer


Particle Size Distribution-Riffle
Box Hill
Reach 2 Station 6+25
September 24, 2004
Percent Finer
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0.01
0.10
1.00
10.00
100.00
1000.00
Particle Size (mm)
Percent Frequency
Cumulative Percent Finer

APPENDIX F
MACROINVERTEBRATE DATA

Table 1. Pre-construction biological condition using Save Our Streams analysis Protocol.

Year	Season	Station	Metric	Metric Value	Metric Score	Condition
1998	Fall	HAR006	TOTTAX	6	0	Poor
			FBI	5.8	3	Fair
			DOMTOT	.556	3	Fair
			EPTTAX	2	0	Poor
			EPTTOT	.578	3	Poor
			TOTAL SCORE		9	Poor
2000	Spring	HAR006	no individual scores available			
			TOTAL SCORE		3	Poor
2000	Spring	HAR007	no individual scores available			
			TOTAL SCORE		3	Poor
2002	Fall	HAR006	TOTAX	6	0	Poor
			FBI	7.48	0	Poor
			DOMTOT	.553	3	Fair
			EPTTAX	1	0	Poor
			EPTTOT	.092	0	Poor
			TOTAL SCORE		3	Poor

Maryland's Save Our Streams Project Heartbeat Sampling and Analysis Protocol

TOTAX: Taxa richness. The total number of taxa represented in the sample

FBI: Family Biotic Index. The number of individuals in each taxon is multiplied by the Hilsenhoff tolerance value. The sum of the products is divided by the total individuals in the sample

DOMTOT: The ratio of the number of individuals in the dominant taxon to total individuals in the sample.

EPTTAX: The number of Ephemeroptera (E), Plecoptera (P), and Trichoptera (T) taxa in the sample.

EPTTOT: The ratio of total EPT individuals to total individuals.

Table 2. Pre- and Post-construction analysis using Maryland Biological Stream Survey analysis protocol.

Year	Season	Station	Metric	Metric Value	Metric Score	Condition
2003	Summer	HAR006	# Taxa	12	1	
			# EPT Taxa	1	1	
			# Ephem Taxa	0	1	
			% Ephem	0	1	
			% Tany of Chiro	0	1	
			# Diptera taxa	7	3	
			% Collectors	0	1	
			% Tolerant	100	1	
			# Intolerant	0	1	
			IBI Score		1.2	Very Poor
2004	Spring	HAR006	# Taxa	8	1	
			# EPT Taxa	0	1	
			# Ephem Taxa	0	1	
			% Ephem	0	1	
			% Tany of Chiro	3	3	
			# Diptera taxa	8	3	
			% Collectors	0	1	
			% Tolerant	100	1	
			# Intolerant	0	1	
			IBI Score		1.4	Very Poor

Table 3. Pre-construction habitat assessment

Year	Station	Att	Emb	Shel	Ch Alt	Sed	Vel	Flow	Veg	Bank	Rip	Total Score	Condition
1998	HAR006	13	12	6	14	14	9	13	3.5	8	0	104	Partially Supporting
2000	HAR006	19	13	13	14	8	9	7	5	11	9	108	Partially Supporting
2000	HAR007	19	13	8	12	3	2	7	6	10	8	88	Partially Supporting

Maryland Save Our Streams Project Heartbeat Habitat Assessment Protocol

Att: Attachment sites for macroinvertebrates
Emb: Embeddedness
Shel: Shelter for fish
Ch Alt: Channel alteration
Sed: Sediment deposition
Vel: Stream velocity and depth
Flow: Channel flow status
Veg: Bank vegetative protection
Bank: Condition of banks
Rip: Riparian vegetative zone width

Table 4: Box Hill Macroinvertebrate Identification

	Pre-Construction				Post-Construction
	HAR006	HAR006	HAR007	HAR006	HAR006
	4/18/2002	9/2/2002	9/13/2002	7/22/2003	5/5/2004
ORGANISM					
OLIGOCHAETA					
LUMBRICULIDAE	2	36	1	8	3
NAIDIDAE	2			4	97
GASTROPODA					
PHYSIDAE					
Physella sp				2	3
ISOPODA					
ASELLIDAE					
Lirceus sp				1	
ODONATA					
AESNIDAE					
Boyeria sp.		2			
TRICHOPTERA					
HYDROPSYCHIDAE					
Cheumatopsyche sp.		6	4	35	
COLEOPTERA					
ELMIDAE					
Stenelmis sp.		1			
DIPTERA					
CHIRONOMIDAE					
Chironomini				4	
Diamesinae					
Diamesa sp.	2				
Tanytarsini					4
Orthocladinae				20	21
Heterotrissocladius sp.	1				
Tanypodinae		1		1	4
SIMULIDAE					
Simulium sp				4	4
TIPULIDAE					
Tipula sp.		19	3	1	
TOTAL NUMBERS	7	65	8	80	138

2002 samples collected by Save Our Streams. 2003 samples collected by Maryland Department of Natural Resources. All samples identified by Maryland Department of Natural Resources.

APPENDIX G
MDE PERMIT

STATE OF MARYLAND
DEPARTMENT OF THE ENVIRONMENT
WATER MANAGEMENT ADMINISTRATION
LETTER OF AUTHORIZATION

AUTHORIZATION NUMBER: 00-NT-0542/2000161040

EFFECTIVE DATE: September 16, 2002

EXPIRATION DATE: September 16, 2005

AUTHORIZED PERSON: Harford County Department of Public Works
212 S. Bond Street, 3rd Floor
Bel Air, Maryland 21014

Attn: Ms. Elizabeth Weisengoff

IN ACCORDANCE WITH ENVIRONMENT ARTICLE §5-503(a) AND §5-906(a), ANNOTATED CODE OF MARYLAND (1996 REPLACEMENT VOLUME), COMAR 26.17.04 AND 26.23.01, AND THE ATTACHED PERMIT CONDITIONS OF AUTHORIZATION, Harford County Department of Public Works , ("AUTHORIZED PERSON"), IS HEREBY AUTHORIZED BY THE WATER MANAGEMENT ADMINISTRATION ("ADMINISTRATION") TO CONDUCT A REGULATED ACTIVITY IN A NONTIDAL WETLAND, BUFFER, OR EXPANDED BUFFER, AND/OR TO CHANGE THE COURSE, CURRENT OR CROSS-SECTION OF WATERS OF THE STATE, IN ACCORDANCE WITH THE ATTACHED PLANS APPROVED BY THE WATER MANAGEMENT ADMINISTRATION, NONTIDAL WETLANDS AND WATERWAYS DIVISION ON September 16, 2002, ("APPROVED PLAN") AND PREPARED BY Greenhorne & O'mara, Inc. AND INCORPORATED HEREIN, AS DESCRIBED BELOW:

Stabilization of approximately 1,100 linear feet of Box Hill South tributary including the installation of step pools, cross vanes, boulders, and grading. The project is located south of Kensington Parkway between Harrowgate Way and Laurel Bush Road, in Harford County, Maryland. The proposed project will impact approximately 1,100 linear feet of tributary and however, will not affect any nontidal wetlands or wetland buffers.

MD Grid Coordinates: 600174± N; 997874± E

FOR Amanda L. Sigillito, Chief
Nontidal Wetlands & Waterways Division

Attachments: Conditions of Authorization
U.S. Army Corps of Engineers Authorization (MDSPGP)

cc: U.S. Army Corps of Engineers (David Olson)
Compliance Program w/ file
Greenhorne & O'mara, Inc., Robert Naumann

THE FOLLOWING CONDITIONS OF AUTHORIZATION APPLY TO ALL ACTIVITIES AUTHORIZED BY AUTHORIZATION NO. 00-NT-0541/2000161040:

GENERAL CONDITIONS

1. Validity: Authorization is valid only for use by Authorized Person. Authorization may be transferred only with prior written approval of the Administration. In the event of transfer, transferee agrees to comply with all terms and conditions of Authorization.

2. Initiation of Work, Modifications, and Extension of Term: Authorized Person shall initiate authorized activities within two (2) years of the Effective Date of this Authorization or the Authorization shall expire. Authorized Person may submit written requests to the Administration for (a) extension of the period for initiation of work, (b) modification of Authorization, including the Approved Plan, or, (c) not later than 45 days prior to Expiration Date, an extension of the term. Requests for modification shall be in accordance with applicable regulations and shall state reasons for changes, and shall indicate the impacts on nontidal wetlands, streams, and the floodplain, as applicable. The Administration may grant a request at its sole discretion.

3. Responsibility and Compliance: Authorized Person is fully responsible for all work performed and activities authorized by this Authorization shall be performed in compliance with this Authorization and Approved Plan. Authorized Person agrees that a copy of the Authorization and Approved Plan shall be kept at the construction site and provided to its employees, agents and contractors. A person (including Authorized Person, its employees, agents or contractors) who violates or fails to comply with the terms and conditions of this Authorization, Approved Plan or an administrative order may be subject to penalties in accordance with §5-514 and §5-911, Environment Article, Annotated Code of Maryland (1996 Replacement Volume).

4. Failure to Comply: If Authorized Person, its employees, agents or contractors fail to comply with this Authorization or Approved Plan, the Administration may, in its discretion, issue an administrative order requiring Authorized Person, its employees, agents and contractors to cease and desist any activities which violate this Authorization, or the Administration may take any other enforcement action available to it by law, including filing civil or criminal charges.

5. Suspension or Revocation: Authorization may be suspended or revoked by the Administration, after notice of opportunity for a hearing, if Authorized Person: (a) submits false or inaccurate information in Permit application or subsequently required submittals; (b) deviates from the Approved Plan, specifications, terms and conditions; (c) violates, or is about to violate terms and conditions of this Authorization; (d) violates, or is about to violate, any regulation promulgated pursuant to Title 5, Environment Article, Annotated Code of Maryland as amended; (e) fails to allow authorized representatives of the Administration to enter the site of authorized activities at any reasonable time to conduct inspections and evaluations; (f) fails to comply with the requirements of an administrative action or order issued by the Administration; or (g) does not have vested rights under this Authorization and new information, changes in site conditions, or amended regulatory requirements necessitate revocation or suspension.

6. Other Approvals: Authorization does not authorize any injury to private property, any invasion of rights, or any infringement of federal, State or local laws or regulations, nor does it obviate the need to obtain required authorizations or approvals from other State, federal or local agencies as required by law.

7. Site Access: Authorized Person shall allow authorized representatives of the Administration access to the site of authorized activities during normal business hours to conduct inspections and evaluations necessary to assure compliance with this Authorization. Authorized Person shall provide necessary assistance to effectively and safely conduct such inspections and evaluations.

8. Inspection Notification: Authorized Person shall notify the Administration's Compliance Program at least five (5) days before starting authorized activities and five (5) days after completion. For Frederick, Washington, Allegany and Garrett counties, Authorized Person shall call (301) 689-8494. For all other counties, call the Baltimore office at (410) 631-3510.

9. Sediment Control: Authorized Person shall obtain approval from the Harford Soil Conservation District (if required) for a grading and sediment control plan specifying soil erosion control measures. The approved grading and sediment control plan shall be included in the Approved Plan, and shall be available at the construction site.

10. Federally Mandated State Authorizations:
__X__ Water Quality Certification: Water Quality Certification is granted for this project provided that all work is performed in accordance with the authorized project description and associated conditions.
__X__ Coastal Zone Consistency: This Authorization constitutes official notification that authorized activities are consistent with the Maryland Coastal Zone Management Program, as required by Section 307 of the Federal Coastal Zone Management Act of 1972, as amended. Activities within the following counties are not subject to this requirement: Allegany, Carroll, Frederick, Garrett, Howard, Montgomery, and Washington.

11. Best Management Practices During Construction: Authorized Person, its employees, agents and contractors shall conduct authorized activities in a manner consistent with the Best Management Practices specified by the Administration.

12. Disposal of Excess: Unless otherwise shown on the Approved Plan, all excess fill, spoil material, debris, and construction material shall be disposed of outside of nontidal wetlands, nontidal wetlands buffers, and the 100-year floodplain, and in a location and manner which does not adversely impact surface or subsurface water flow into or out of nontidal wetlands.

13. Temporary Staging Areas: Temporary construction trailers or structures, staging areas and stockpiles shall not be located within nontidal wetlands, nontidal wetlands buffers, or the 100-year floodplain unless specifically included on the Approved Plan.

14. Temporary Stream Access Crossings: Temporary stream access crossings shall not be constructed or utilized unless shown on the Approved Plan. If temporary stream access crossings are determined necessary prior to initiation of work or at any time during construction, Authorized Person, its employees, agents or contractors shall submit a written request to the Administration and secure the necessary permits or approvals for such crossings before installation of the crossings. Temporary stream access crossings shall be removed and the disturbance stabilized prior to completion of authorized activity or within one (1) year of installation.

15. Discharge: Runoff or accumulated water containing sediment or other suspended materials shall not be discharged into waters of the State unless treated by an approved sediment control device or structure.

16. Instream Construction Prohibition: To protect important aquatic species, activities within stream channels are prohibited as determined by the classification of the stream (COMAR 26.08.02.08):
Box Hill South tributary is a Use III Waterways: However, Use I limits are more appropriate consequently instream work may not be conducted from, March 1 through June 15 inclusive, of any year.

17. Instream Blasting: Authorized Person shall obtain prior written approval from the Administration before blasting or using explosives in the stream channel.

18. Minimum Disturbance: Any disturbance of stream banks, channel bottom, wetlands, and wetlands buffer authorized by Permit or Approved Plan shall be the minimum necessary to conduct permitted activities. All disturbed areas shall be stabilized vegetatively no later than seven (7) days after construction is completed or in accordance with the approved grading or sediment and erosion control plan.

19. Restoration of Construction Site: Authorized Person shall restore the construction site upon completion of authorized activities. Undercutting, meandering or degradation of the stream banks or channel bottom, any deposition of sediment or other materials, and any alteration of wetland vegetation, soils, or hydrology, resulting directly or indirectly from construction or authorized activities, shall be corrected by Authorized Person as directed by the Administration.

20. The permitee shall monitor the stream restoration project for a minimum of five (5) years following the completion of construction of the project. The monitoring shall identify and evaluate changes in channel cross-section; pattern and profile; bed materials; channel stability; structure stability and condition; and vegetation viability. The monitoring effort shall include topographic surveys of monumented cross-sections within the realigned channel segment, visual field observations, photographic documentation, vegetation viability measurements, and identify any necessary corrective measures.

21. The permittee shall submit annual reports on the results of the monitoring efforts at the stream restoration project to the Department by the anniversary date of the completion of construction. The permittee shall coordinate with the regulatory agencies concerning applicable remedial measures for any identified project failures and shall correct any project failures within one year of their identification.

U.S. ARMY CORPS OF ENGINEERS AUTHORIZATION

The project is authorized by the U.S. Army Corps of Engineers under the Maryland State Programmatic General Permit, Category III, subject to the attached General Conditions of the MDSPGP.